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ECONOMIC GROWTH IN YUKON 1983 TO 2003

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I. CONCLUSIONS IN BRIEF

Table 1 very briefly summarizes the projections made for this study. The underlying assumptions for each of the four simulations are presented below at the beginning of Chapter III. Rather than simply repeat what is written in the body of this report, it seems preferable, given the broad scope of coverage, to highlight the more important conclusions reached. In some cases, these conclusions point to the need for further research if clearer answers are to be given. Following the statement of each conclusion a page reference is given so that the reader can, if he or she chooses, refer easily to the sections of the report where that particular matter is discussed.

1. In 1982 Yukon's three basic industries were mining, tourism and federal government. Of the 11,114 year-round full-time equivalent jobs recorded in 1982, approximately 60 percent were directly or indirectly dependent upon federal government, 25 percent on mining, and 15 percent on tourism, (according to multipliers implicit in the Yukon economic model) See Chapter II, pages 35 ff.

2. Widely accepted lead and zinc price expectations hold out little hope for a return to profitability of Dome's Cyprus Anvil operation at Faro for the next several years. See Chapter II, pages 19-23.

TABLE 1

YUKON ECONOMIC SUMMARY

		1988				2003			
	1982	NEGATIVE GROWTH	LOW BUT POS. GROWTH	BASE CASE	HIGH GROWTH	NEGATIVE GROWTH	LOW BUT POS. GROWTH	BASE CASE	HIGH GROWTH
POPULATION	24811	22751	25189	26832	34285	22125	28273	30269	61092
LABOUR FORCE	12818	10647	13224	16216	20724	10354	15720	18320	36922
UNEMPLOYMENT RATE	13.3	13.4	13.4	13.5	10.5	15.4	14.2	14.0	8.5
WAGE & SALARY EMPLOYMENT	9489	8023	9694	11972	15974	6853	11373	12926	29119
SELF-EMPLOYMENT	1625	1465	1664	1936	2574	1366	1885	2167	4665
OCCUPIED HOUSING UNITS	6972	6582	6896	8086	9755	6174	8185	9226	18777
PER CAPITA DISPOSABLE INCOME/1	5786	5361	5731	6646	7678	4756	5796	6095	6426
ENERGY DEMAND/2	8278	7572	8391	9969	13518	7037	9251	10269	22083
ELECTRICITY DEMAND3/	276.6	236.9	271.1	366.9	533.1	186.5	274.9	322.5	757.8
RESIDENTIAL + COMMERCIAL WATER DEMAND4/	2744	2516	2786	2967	3792	2447	3127	3348	6756

1/1976 DOLLARS. EQUIVALENT 1982 DOLLARS OBTAINED BY MULTIPLYING by 2.027, 1983 DOLLARS BY 2.150.
2/TERAJOULES
3/GIGAWATT HOURS
4/MILLIONS OF IMPERIAL GALLONS

3. Prospects for an immediate upswing in tungsten prices of a magnitude needed to encourage the opening of the Mactung operation at Macmillan Pass may depend on the willingness of the U.S. General Accounting Office to curtail sales despite continued surplus in its tungsten inventory. See Chapter II, pages 32-34.

4. Unless the federal government drastically reduces spending in Yukon (more than 50 percent in real terms over 20 years) there is little chance of Yukon's population falling much below 20,000 persons by the year 2003. In the year 1971, Yukon's population was an estimated 18,400 persons and wage and salary employment an estimated 7,086 jobs. Unless Yukon Native people choose to out-migrate heavily, natural increase in the Yukon Native population suggests that by 1971 standards, the year 2003 population-employment ratio implicit in Table 1's NEGATIVE GROWTH column may be high but is not unreasonable. See Chapter III, Tables 9NAT, 9BC, 9LBP, 9NEG, and 9HI.

5. Barring major new mineral discoveries in Yukon or an unexpected change in the structure of World metals markets, it is unlikely that Yukon's population will greatly exceed 70,000 persons by the year 2003. (Results of HIGH GROWTH SIMULATION, adjusted for possible further aging of the population.) See Chapter III, Table 9HI and discussion of assumptions on pages 49-67.

6. Because growth in Yukon's Native population is essentially limited to natural increase, the more rapid the rate of economic growth in Yukon, the smaller becomes the percentage of the Yukon population which is Native. Under the HIGH GROWTH simulation, Yukon Natives decline from an estimated 16.7 percent of the population in 1982, to an estimated 9.1 percent of the population in 2003. See Chapter III, Tables 9NAT, 9BC, 9LBP, 9NEG, and 9HI.

7. Given recent Yukon birth and death rates and in-migration patterns by age group, the percentage of the Yukon population over 65 shows continual increase in the projections made for this report. Because of the high cost of retirement in the Yukon, this may well be an indication that recent in-migration patterns by age-group will not continue in the future. This matter deserves further research. See Chapter III, pages 76-85.

8. In a frontier economy the more rapid the rate of employment growth, the greater the increase in population and in the ratio of dependents to workers. If employment growth is sufficiently rapid, population (via migration) grows increasingly more rapidly than employment (up to a point). This is a conjecture based on current and previous research. The decline in real per capita income shown between 1988 and 2003 in the HIGH GROWTH simulation,

results from the imposition of this conjecture on the simulation, as well as from a decline in high paying pipeline construction jobs. The decline over the same period in BASE CASE real per capita disposable income is, in part, the result of a decline in projected mining employment, and, in part, due to the imposition of the migration conjecture. See Chapter III, pages 73-74.

9. Total energy demand in Yukon is likely to continue to decline in per capita terms, even under HIGH GROWTH assumptions unless the long-term compound annual growth rate of real crude oil prices falls significantly below 2.0 percent per year. In a recent report [19, p. 46], the International Energy Agency concluded that constant real crude oil prices implied significant excess demand by the year 2000, that is, that rising real crude oil prices were required for equilibrium. See Chapter III, pages 90-103.

10. Despite an assumed increase in real electricity prices of 2.0 percent per year, electricity demand can be expected to grow at approximately the rate of growth of population overall, and in excess of the rate of growth of population in the residential sector. This statement assumes no major shift to electric space and water heating, and assumes that the tendency to increased dependence on electrical equipment and appliances will be just offset (from the point of view of electricity con-

sumption) by a technology induced decrease in the power requirements of such equipment. See Chapter III, pages 103-106.

11. Residential and commercial water consumption in Yukon appears to be high by certain standards. If per capita consumption does not decline in these sectors, demand could reach 6.8 million Imperial gallons by the year 2003. See Chapter V, pages 148-155.

12. Special simulations of the NEWYEM econometric model suggest that after five years:
    (a) each new mining job created and sustained leads to the creation of between 1 and 1.5 other Yukon jobs;
    (b) at current per tourist spending rates every extra 1000 "tourists" support between 3 and 4 additional Yukon jobs;
    (c) at current levels, an extra $100,000 per year in real (1983 $) federal spending produces between 2.5 and 3.5 new Yukon jobs; and
    (d) an extra $100,000 per year in real (1983 $) disposable income (via a tax reduction, say) produces between 1.8 and 2.5 new Yukon jobs.

    See Chapter III, pages 85-89 and Chapter IV, pages 129-138.

13. Tourists spend very little "per-tourist" in the Yukon. Programs aimed at raising expenditure per-tourist may more cost-effectively increase total tourist expenditure than programs designed simply to increase the num-

ber of tourists. See Chapter II, page 14, Chapter IV, pages 132-133.

14. Steps to reduce water use in the mining industry (recycling) can reduce both the total demand for water and the potential for degrading surface waters via sedimentation or toxification. However, given the cost disadvantages already faced by the Yukon mining industry, stricter environmental controls may be in a direct trade-off with increased economic growth. See Chapter V, pages 154-155.

Much of the work done for this study went into the preparation of the economic, demographic, and energy demand projections. These projections are intended for use as background by others in providing answers to such questions as the need for new facilities, the desireability of certain policy options, and the potential for social change in Yukon. The conclusions stated above do not exhaust the implications of the work discussed in the following chapters.

Nothing written in this report should be construed as an indicator of general support for or opposition to any particular job creating action or program. The fact that certain actions create jobs does not mean that they do so cost-effectively. Experience with economic development planning in Alaska suggests that Yukon development agencies may from time-to-time find themselves under pressure to support large capital projects on the assumption that private in-

vestors will then be induced to launch major new ventures. Nothing in this report should be interpreted as advocacy of such high-stakes public speculation. In our opinion, prudence dictates that related public and private investments be coordinated as closely as possible. Chapter IV includes a discussion of the rationale for public financial participation in economic development projects. In Chapter III are estimates of public capital required for each scenario. In particular, it was found that

15. BASE CASE public capital requirements average $78.3 million per year (1983 $) over the 1983-2003 period, and total $1.6 billion. For the remaining three scenarios public sector capital required is:

SCENARIO	YEARLY AVERAGE (1983 $)	TOTAL REQUIRED 1983 $
HIGH GROWTH	$225.9 million	$4.7 billion
LOW BUT +	$ 66.6 million	$1.4 billion
NEGATIVE	$ 33.9 million	$0.7 billion

See pages 107-114.

II. STRUCTURE OF YUKON ECONOMY

Yukon is a small open economy largely dependent for its existence on federal government, mining, and tourism. These industries are singled out because they are both basic, in a sense to be defined, and of significant size. For purposes of this report, a "basic" industry is one which either exports goods or services, or (in the case of subsistence) is not dependent upon the presence of a market economy for its existence. Industries which are not "basic" are termed "support" industries.

Oil and gas exploration, subsistence harvesting, and fur trapping are three smaller Yukon basic industries. In 1982, approximately $1.6 million in pelts were reported to have been taken from Yukon.[1/] Definitive estimates of the value of subsistence harvesting of fish, game, berries, and wood products are not available, to our knowledge.[2/] In 1982, there were fewer than 100 year-round-full time Yukon jobs in oil exploration and development.

During 1982 the Yukon economy supported approximately 9,500 wage and salary jobs and 1,600 self-employed workers. Yukon's estimated 24,811 residents realized a per capita disposable personal income of $11,728 dollars, but faced consumer good prices some 16 percent higher than those in Vancouver and 21 percent higher than those in Edmonton.[3/]

1/Statistics Canada as reported in Yukon Economic Review, [30B], first quarter 1983, product of "fur production" and "average fur prices."
2/DIAND [9A] estimates show an annual harvest of approximately one million pounds of meat.
3/Spatial cost of living differentials as published in Yukon Economic Review [30B], p. 26.

Historically, the Territorial economy's pillars (basic industries) have been government spending, mining, and tourism. During 1982, hard rock mining in Yukon was reduced to a holding operation with the closing of Cyprus Anvil (Dome), Whitehorse Copper (Hudson Bay), and United Keno Hill Mines' Elsa operations. Although the figures are not completely comparable, the relative importance of Yukon's three basic industries is not greatly distorted by noting that estimated 1982 calendar year federal government spending in Yukon ($260.4 million) outpaced estimated tourist spending ($60.1 million) at a multiple of 4.3, estimated mining payrolls ($25.8 million) at a multiple of 10.1, and the 1981 value of placer gold produced ($55.1 million), at a multiple of 4.7 (the latter, according to Yukon Exploration and Geology, 1981, [9C]).[1/] Although the relative degree of dependence on federal spending can be debated, there seems little doubt that at least in 1982, federal government was the single most important basic industry in the Territory. With the federal government supplying in excess of 70 percent of the Territorial government budget, direct federal employment alone came to over 30 percent of all wage and salary workers in the Territory.[2/]

1/A curiousity in the D.I.A.N.D. version of the Yukon Territorial Accounts [9A] obscures this relationship. The D.I.A.N.D. tables deduct the federal deficit incurred in the Yukon from current spending in arriving at the figure ostensibly labelled "Total Outlays." Here we define expenditure gross of the deficit and gross of "other current revenue." See [9A], Table 7. Our expenditure estimate also includes estimated capital outlays.

2/(1415 + .7*2141)/9498. The last D.I.A.N.D. Territorial accounts (1978) showed transfers from federal government to be 75.8 percent of Territorial government revenue. See [9A], Table 8.

- PERFORMANCE 1972 TO 1982 -

Tables 2 and 3 summarize the Yukon economy's performance during the decade which ended in 1982. Over that ten year span, population rose 27.2 percent and real (inflated adjusted) disposable personal income 18.1 percent. Were it not for the sharp decline in mining employment that was registered in 1982 (down over one-half from 1981), registered overall growth would have been somewhat more impressive.

As of March 1983, almost 70 percent of the Yukon population was concentrated in Whitehorse (16,463 persons), with the next largest community, Faro, showing less than 8 percent of the total (1,841 persons). Other than Faro and Whitehorse, only Watson Lake (1,361 persons) and Dawson City (1,268 persons) have current populations in excess of 1,000 persons.[1/] With the closing of Cyprus Anvil's Faro operation in 1982, and the financial difficulties faced by owner Dome Mines and its parent Dome Petroleum, Faro may soon fall further behind Whitehorse in relative population.

The 1972-1982 Yukon economic performance is unusual for its balance. As can be seen from Table 3, even given the cyclical drop in mining employment that occurred in 1982, the composition of wage-salary employment was not markedly different in 1982 than in 1972. A comparison of 1972 employment to 1982 employment shows only two significant changes apart from the previously mentioned dip in mining. (Where by "significant" is meant large both absolutely and as a percent of the total.) Territorial government employment nearly doubled, while services/trade employment grew nearly 60 percent,

1/ Yukon Economic Review [30B], first quarter 1983, p. 5.

TABLE 2
YUKON ECONOMIC HISTORY
1972,'75,'78,'82

INDICATOR	1972	1975	1978	1982	PERCENT CHANGE 1972 TO 1982
POPULATION	19500	21300	23305	24811	27.2
LABOUR FORCE	10100	12100	12264	12818	26.9
UNEMPLOYMENT RATE (%)	11.8	17.3	18.9	13.3	--
WAGE/SALARY EMPLOYMENT	7318	8109	9061	9489	29.7
OCCUPIED HOUSE UNITS	5980	6584	7609	7442	24.4
REAL PER CAPITA DISP. INCOME<1>	4898	6034	6041	5796	18.1
NOM. PER CAPITA DISP. INCOME<2>	3233	5533	7328	11728	262.8
PERCENT CHANGE YUKON CPI<3>	5.8	27.4	10.7	11.4	--

NOTES: (A) 'Occupied Housing Units' is estimated by regression for inter-censal years. See Reaume <23B>.
(B) Yukon CPI is a population weighted average of the indexes for Whitehorse, Dawson City, and Watson Lake. See Reaume <23B>.

1) 1976 dollars
2) not adjusted for changes in the Yukon CPI
3) percent change in the annual average of the Yukon CPI from the year previous

TABLE 3
YUKON EMPLOYMENT BY INDUSTRY
1972,'75,'78,'82

INDUSTRY	LEVEL '72	'75	'78	'82	PERCENT OF TOTAL '72	'75	'78	'82	% CHANGE '72 TO '82
MINING	1203	1404	1429	693	16.4	17.3	15.8	7.3	-42.4
CONSTRUCTION	502	612	801	582	6.9	7.5	8.8	6.1	15.9
COMM & UTILS	342	292	346	489	4.7	3.6	3.8	5.2	43
TRANSPORT	596	666	741	678	8.1	8.2	8.2	7.1	13.8
SVCS & TRADE	1940	1710	2081	3051	26.5	21.1	23	32.2	57.3
FEDERAL GOVT	1028	1378	1373	1415	14	17	15.2	14.9	37.6
TERR GOVT	1209	1543	1755	2141	16.5	19	19.4	22.6	77.1
LOCAL GOVT	123	146	164	222	1.7	1.8	1.8	2.3	80.5
OTHER	375	358	371	218	5.1	4.4	4.1	2.3	-41.9
TOTAL	7318	8109	9051	9489	100	100	100	100	29.7

SOURCE: 'YUKON ECONOMIC REVIEW' <30b>. PRE-1978 DATA FOR CONSTRUCTION COMMUNICATIONS & UTILITIES, TRANSPORTATION, AND SERVICES & TRADE ARE ESTIMATED. SEE REAUME <23b>.

NOTE: MINING EMPLOYMENT FOR 1982 IS ADJUSTED FROM THAT PUBLISHED IN <30b>. AS NOTED THERE THE PUBLISHED 1982 FIGURE INCLUDES 554 EMPLOYEES DESIGNATED FULL TIME BY CYPRUS ANVIL, A MAJORITY OF WHICH WERE ON STANDBY, REDUCED HOURS, OR VACATION PAY.

adding over 1000 full time equivalent jobs.

The surge in Territorial government employment reflects in large part, increases in federal government transfers. Between 1972 and 1978 federal transfers to the Territorial government rose 164 percent in nominal dollars and 43.6 percent in constant 1976 dollars.[1/] Although consistent data are not as yet available for 1982, it appears from the continued growth in Territorial government employment and the absence of major tax changes that Territorial government revenue dependence on the federal government has certainly not lessened significantly. In 1978 approximately 75 percent of total Territorial government revenue was accounted for by federal transfers.[2/]

The 1972-1982 gain in services/trade employment may have occurred despite a decline in real tourist expenditure. Between 1972 and 1982, officially estimated real (inflation adjusted) tourist spending actually declined, despite a 43 percent increase in the number of border crossings. According to Yukon Tourism Industry Highlights, 1982, [31], estimated tourist expenditures rose from $21.8 million in 1972 to $5.1 million in 1982, a gain insufficient to offset the 207 percent increase in the Yukon CPI which was registered over the same period. Because of acknowledged uncertainty in the tourist expenditure estimates, however, one cannot be certain of the precise historical trend.

1/Yukon Economic Accounts [9A], Table 8. Constant dollar figures obtained by deflating with the Yukon CPI defined in Reaume [23B].
2/Ibid.

HARD ROCK MINING

According to D.I.A.N.D., commercial or potential commercial deposits of the following occur in Yukon: lead, zinc, copper silver, gold, tungsten, molybdenum, barite, nickel, platinum, coal, and iron; with the first six occurring the most widely.[1/]

Table 4 presents the recent history of market prices for the first seven of these minerals, in both current U.S. dollars and U.S. dollars deflated by the Canada CPI, base year 1971. (Over this time period, the annual average U.S. dollar price of the Canadian dollar remained relatively stable, lying in the range of 0.80 to 0.86.) As can be seen, since 1980 constant dollar prices have declined from recent historical peaks.

As a direct result of low lead and zinc prices, both the Cyprus Anvil mine at Faro and the United Keno Hill operation at Elsa had been shut down by the end of 1982. Between 1981 and 1982 estimated average revenue receivable per tonne of ore milled (1980 $) dropped from $65.28 to $48.62 at Cyprus Anvil and from $256.24 to $202.53 at United Keno Hill. In 1980, their respective average revenues per tonne had stood at $83.51 and $685.83,

1/ Yukon Exploration and Geology, 1981 [9C]. See also "Yukon Mines And Mineral Deposits," [30A].

TABLE 4

METAL PRICES
(Current $)

	1977	1978	1979	1980	1981	1982	August 1983
Lead, LME ¢/lb	28.00	29.86	54.52	41.21	33.30	24.66	17.95
Zinc, PW, LME, ¢/lb	26.71	26.88	33.59	34.47	38.34	33.73	35.23
Copper, LME Hi-Grade ¢/lb	59.44	61.80	90.07	99.25	79.35	67.16	76.16
Silver, Handy Harman $/Troy ounce	4.62	5.40	11.09	20.63	10.52	7.95	11.76
Gold, Englehard $/Troy oz	148.31	193.55	307.50	612.56	459.64	375.91	412.05
Tungsten, $/US Spot Short Ton, Metals Week	148.88	128.33	127.31	129.80	129.23	NC	79.00
Molybdenum, MW Dealers Oxide, $/lb	5.80	17.50	15.08	9.98	6.40	4.10	4.00
Canada CPI (1971=1.000)	1.608	1.752	1.912	2.106	2.369	2.625	2.756
			(1971 $)				
Lead	17.41	17.04	28.51	19.57	14.06	9.39	6.51
Zinc	16.61	15.34	17.57	16.37	16.18	12.85	12.78
Copper	36.97	35.32	47.11	47.13	33.50	25.58	27.63
Silver	2.87	3.08	5.80	9.80	4.44	3.03	4.27
Gold	92.23	110.47	160.83	290.86	194.02	143.20	149.51
Tungsten	92.59	73.25	66.58	61.63	54.55	NC	28.66
Molybdenum	3.61	9.99	7.89	4.74	2.70	1.56	1.45

SOURCE: 1977-1981 U.S. Bureau of Mines [18B].
1982-1983 Metals Week [16].

NOTE: The 1983 value of the CPI assumes an annual average 5.0 percent increase in 1983. This is the percentage gain projected for 1983 by the Organization For Economic Cooperation and Development. See [21A], Table 5, p. 29.

TABLE 5
METALS: PRODUCERS, USES, DEMAND

METAL	LEADING PRODUCERS	PRINCIPAL USES	PROJECTED 1980-2000 ANNUAL GROWTH IN MARKET
LEAD	U.S., U.S.S.R., Australia, Canada	batteries, tetraethyl, construction, paints	2.2% (Bumines) 2.0% (R.F.F.) 2.0% (C.M.Y.)
ZINC	Canada, U.S.S.R., Australia, Peru	galvanizing, brass & bronze products, castings, pigments, coinage	2.1% (Bumines) 2.4% (R.F.F.) 2.1% (SRI)
COPPER	U.S., Chili, Canada, U.S.S.R., Zambia	electrical equipment, construction, tubing	3.9% (Bumines) 2.7% (R.F.F.)
TUNGSTEN	China, U.S.S.R., U.S., Bolivia, South Korea, Canada, Australia, Thailand	carbide tools, alloys, for high speed tool & die steels, chemicals	3.5% (Bumines)
BARITE	U.S., U.S.S.R., China, Peru	well drilling "mud," chemicals	1.1% (Bumines)
MOLYBDENUM	U.S., Canada, U.S.S.R., Chile	alloy in steels etc., chemicals	4.5% (Bumines)
SILVER	Mexico, Canada, U.S., U.S.S.R	photography, sterlingware, electronics, investment holdings	2.3% (Bumines) (commercial uses)
GOLD	South Africa, U.S.S.R., Canada, U.S.	jewelry, electronics, investment holdings	1.4% (Bumines) (commercial uses)

NOTE: Bumines - U.S. Bureau of Mines [18B]; R.F.F.- Resources For The Future [10]; C.M.Y. - Canadian Minerals Yearbook [8B]; SRI - S.R.I. International as quoted by Shearson American Express [26], p. 54.

respectively.[1/] We impute from this that breakeven revenue per tonne of ore milled is presently about $57.00 for Cyprus Anvil and $241.00 for United Keno Hill (1980 Canadian dollars). At the August 1983 prices shown in Table 4, estimated Cyprus Anvil revenue per tonne in 1980 Canadian dollars would be $43.66, and United Keno Hill $274.83. It thus appears that the rise in real silver prices achieved so far this year has been sufficient to bring United Keno Hills' Elsa operation back to profitability but not enough to do so for Cyprus Anvil.[2/]

The performance of metal prices is, of course, the key to predicting the level of future mining and milling activity in the Yukon. As of December 1982, D.I.A.N.D. had classified over forty separate prospects as "major discoveries." Far and away the largest number of these offer some combination of lead, zinc, silver, and gold. A smaller but potentially significant subset of properties show grades of wolframite (tungsten) that could become commercially attractive in the not too distant future. Other prospects show molybdenum, copper, iron, nickel, barite, and coal. The remainder of this section focuses on the markets for lead, zinc, silver, gold, tungsten, barite, and molybdenum. Table 5 gives the leading producers, principal uses, and some recently projected long term growth rates (demand) for each of these minerals.

1/Alaska Economics, Incorporated estimates, Canadian dollars. Based on published lead, zinc, copper, gold content of representative ores from each mine. These estimates are only approximate and would change as the grade of ore changes.

2/The Elsa mine produces on the order of twenty to thirty times the quantity of silver per tonne of ore milled as does Cyprus Anvil.

Lead

In mid-year 1983, Shearson American Express' London Metals Research Unit had this to say: "Longer term environmentalist pressures could remove 5-10% of lead's current market whilst lead's low GDP intensity of use...gives little encouragement for the longer term."[1/]

The environmentalist pressures referred to in this quotation stem principally from concern over the ingestion of lead-based household paints by children and the inhalation of lead components released in motor vehicle exhausts. These pressures have led to the phasing out by many countries of lead additives in gasoline and to a widespread shifting away from the use of lead in household paints. At the present time growth in lead demand would appear to depend on increased production of storage batteries, a market aided somewhat by the growing popularity of diesel powered vehicles (which require relatively hefty batteries).

At the present time, the market is still adjusting to the shift in demand patterns noted above, in the sense that many mining prospects which might have been commercially viable in the early 1970's are no longer so, but still seem attractive to some observers. Between 1973 and 1979 the World's leading consumer of

1/[26], p. 32.

primary lead (the U.S.) cut its annual demand from 962 thousand metric tonnes to 731 thousand metric tonnes, an annual average drop in demand of 4.6 percent. In contrast, during the preceding six year period, U.S. demand increased 6 percent per year.

Despite the downshift in lead demand which occurred in the 1970's exploration and discovery continued apace. New discoveries in the Yukon listed as "major" by D.I.A.N.D. and their discovery dates include: Vera (1978), Jason (1974), and Gayna River (1974). Major mines to be discovered or come into production worldwide since 1973 include: Cominco's Polaris mine on Little Cornwallis and Red Dog mine in Northwest Alaska; Cadillac Exploration's Prairie Creek operation in the Northwest Territories; Black Mountain's Broken Hill mine in South Africa; discoveries by St. Joe Lead Company in Missouri (where approximately two-thirds of the U.S. supply of primary lead originates), and other discoveries in the U.S.S.R., Mexico, Australia, the U.S., Canada, and other countries. Worldwide, lead is mined in approximately forty-five countries.

Given the relatively slow growth in demand for primary lead projected through the year 2000 (see Table 5), there seems little likelihood that lead prices will rise in real terms fast enough to justify the operation of relatively low grade ore bodies. Of twenty-one "principal" Canadian lead mines listed in the 1981 Canadian Minerals Yearbook, the Yukon's Cyprus Anvil mine ranked seventh and United Keno Hill sixth, in recoverable lead per tonne of ore milled. In addition, Cyprus Anvil ranked fourteenth in recoverable silver per tonne, ninth in recoverable gold per tonne, and ninth in recoverable zinc per tonne while United Keno Hill was first in recoverable silver per tonne by a wide margin. By this standard neither Cyprus Anvil nor United Keno Hill are particularly low grade ore bodies, since both rank in the upper half of the Yearbook's list of principal lead mines in Canada by the standard of relative ore grade.

What this comparison leaves out, however, is an important point. Any ore prospect's commercial attractiveness depends on the amount by which revenue obtained from a tonne of milled ore exceeds the sum of the variable and amortized fixed costs of extracting and milling that ore. For the forseeable future, it seems likely that only mines for which the absolute cost of producing lead is

relatively low, or mines which produce substantial amounts of co-products (silver, zinc, gold) will prove commercially feasible. Furthermore, the need to cover the amortized fixed costs of production suggests in the present market environment, that relatively small ore bodies will need to be more than proportionately higher in grade.

Price predictions by Shearson American Express and other market participants call for lead prices to remain depressed relative to other metals prices. If so, there is little likelihood that Yukon mines producing principally lead or lead and zinc will go into production for several years.

Zinc

Whereas lead prices have continued to decline in 1983 even in nominal terms, zinc prices have begun to rise. (See Table 4, above.) In part because zinc is the fourth most heavily consumed metal in tne World (behind steel, aluminum, and copper), the ratio of reserves to total demand is lower than that of lead (its usual co-product). However, with recycled lead meeting approximately one-third of total World lead demand, and recycled zinc only about 5 percent of total World zinc demand, the ratio of reserves to the demand for primary metal is substantially lower for zinc than for lead.[1/] Given the possibility of future

1/In 1978, the ratio of reserves to primary demand was 25:1 for zinc and 40:1 for lead. (Calculated from figures in U.S. Bureau of Mines [18B]).

increases in the fraction of total lead demand satisfied by recycled lead, there is good reason to expect zinc prices to rise faster than lead prices in the long term.

The 1981 Canadian Minerals Yearbook [8B] listed nineteen zinc deposits considered "most promising for future production." Six of these are in the Yukon. They are: Cyprus Anvil's Grum and Vangurda prospects, Hudson Bay's Tom, Ogilvie Joint Venture's Jason, Placer/U.S. Steel's Howard's Pass, and Sulpetro/Sovereign's MEL. All six of these prospects grade at least 5.1 percent zinc and have in excess of 4.5 million indicated tonnes of ore. The largest is the Howard's Pass prospect, with an estimated 272 million tonnes of ore grading 6.4 percent zinc (since 1981 re-estimated at 113.4 tonnes grading 5.4 percent zinc and 2.1 percent lead). The Tom and Jason properties contain much less ore, 4.5 million tonnes, but are richer and offer small quantities of silver in addition.[1/]

As of August 1983 real zinc prices were 25 percent below the 1979-1980 average. Should real market prices again approach the 1979-1980 level, one or more of these six prospects might become economically feasible. If price increases average two percentage points above the rate of cost escalation, this could occur by the middle 1990's.

We make this statement because by comparison to Cyprus Anvil's Faro operation several have higher grade ores (Faro grades 5.4%

1/Tom (8.6% Pb, 8.4% Zn, 96 g/t Ag), Jason (7.4% Pb, 7.2% Zn, 86 g/t Ag) per [30].

Zn, 3.8% Pb, and 53 g/t Ag), and one is quite large. If, indeed, the Faro operation was profitable in 1979 and 1980, then one or more of the six "promising" zinc prospects in the Yukon may also prove to be so, should real zinc prices rise 2 percent per year, on average, for ten to fifteen years. Continued weakness in lead prices, of course, lessens this potential.

Silver

When silver prices rebounded from their 1982 lows in the latter part of the year and continued strong through the first six months of 1983, United Keno Hill's Elsa mine was put back into production (June 1983). Through September 1983, silver prices have remained well above their 1982 average.

Because silver is in part a commercial commodity (photography, electronics, jewelry, and sterlingware), one has a basis for projecting demand and price. Because large quantities are held for investment purposes by members of the general public, its price variations can be more difficult to anticipate than those of the major metals.

Between 1958 and 1972 real (inflation adjusted) silver prices rose only about 1.6 percent per year, and except for a surge in 1968 exhibited rather stable growth. In 1973 real silver prices rose 43.1 percent and in 1974 67.7 percent. These gains were followed by declines of 14.4 percent in 1975 and 6.2 percent in 1976.

After a two year period of stability, real silver prices shot up 88.3 percent in 1979 and a further 69 percent in 1980. In 1981 and 1982, real silver prices dropped 54.7 percent and 31.8 percent, respectively.

Silver and gold are two of the more popular commodity hedges against inflation and currency instability. The similarity of timing between the beginning of silver price volatility and the first major OPEC crude oil price increases is not merely coincidental.

Silver's role as an investment vehicle invites some market analysts to develop behavioral rules of thumb as to the likelihood of price change in a given direction. In our opinion, these rules have little or no value. One such rule of thumb which has become popular is that the ratio of the price of gold to the price of silver is "normally" 35 to 1. While it is true that since 1973 the gold/silver price ratio has varied about an arithmetic mean of approximately 35 to 1, there has been little stability to the ratio.[1/] Furthermore, knowledge that a 35 to 1 ratio is "normal" is of little use to investors if one does not know how readjustment back to the "norm" will take place. For example, between mid-1982 and mid-1983 the gold/silver price ratio declined from 47 to 1 to 35 to 1. In the process, <u>both</u> gold and silver prices went up. A similar decline in the gold/silver price ratio could have been achieved (a) by both prices declining, but gold more so than silver; (b) by gold prices falling while silver prices

1/The ratio of annual average prices has gone as high as 47 to 1 (1982) and as low as 28 to 1 (1979) over this period. On a daily or monthly basis the swings have been even more severe.

remained stable; (c) by gold prices remaining stable while silver prices rose; (d) ,...by an infinite assortment of magnitudes of change of these types over any period of time.

Silver, and to an even greater degree gold, are two commodities for which current production (say, one year's newly mined metal) represents a relatively small fraction of stocks available for trading. To a lesser degree, all metals are sold in markets having this characteristic. Silver and gold are at an extreme because of their common use as a store of wealth. The relative importance of pre-existing stocks in the markets for silver and gold contrasts sharply with the predominance of current production in most other markets, grain markets being a particularly obvious example of the latter.

Because of the relative unimportance of current production in price determination, speculative swings in price are not as quickly countered by variations in current production. As a result, speculation is more likely to be destabilizing and price swings more violent than in other markets.[1/] Because mining companies presumeably are aware of this, their willingness to act on what may be only a temporary or speculative price increase can be expected to be limited.

In the economic forecasts presented later in this report, we assume that the price increases which we hypothesize are generally

1/Gardner Ackley made this point in his December 1982 presidential address to the American Economic Association. See [1].

believed to be long-term-sustainable. This does no harm unless one forgets that the actual response to a given price increase is not likely to be as immediate as our simulations might suggest.

All this having been said, we can now offer the observation that silver is likely to play a pivotal role in the Yukon's economic future (as will gold and tungsten as we note below), in the sense that the potential for the profitable milling of silver could well spark the opening of new hard rock mines. In rating Yukon lead-zinc projects as more or less likely to become commercially feasible, we believe emphasis should be placed on the relative capacity of each to produce silver, rather than on their capacity to produce lead and zinc, two of the Yukon's traditionally leading hard rock metals. This observation is based on the belief that lead and zinc prices are not likely to rise as rapidly in the next decade or two as silver prices.

In the words of Shearson American Express

> "Longer term....prospects are brighter than for several years with photography use and high technology applications on the uptrend...We expect a steady upward movement in average silver prices with some speculative peaks." [26] p. 9.

Gold

Barring new discoveries, the principal impact of World gold price movements on the Yukon economy will be via their effect on placer

mining. The following brief history of the Yukon placer mining industry is reprinted from R.L. Debicki's "Placer Mining Industry In Yukon and Atlin Mining Division, British Columbia.[1/]

> "Yukon is famous for the stampede of prospectors to the Klondike in 1898 after news of the rich placer deposits discovered in the area reached them. Placer mining had, however, been carried on in the territory for many years prior to the gold rush.
>
> The first miners were undoubtedly Indians who recovered native copper from Kletsan Creek at the headwaters of the White River. Hudson's Bay Company explorer Robert Campbell reported gold at Fort Selkirk in 1850. Prospecting parties moved into Yukon in 1872, after activity in the Cariboo placer district to the south had cooled. That year, the party of Arthur Harper, Leroy (Jack) McQuesten, and Albert Mayo reported gold "colours" on the Porcupine River, and "colours everywhere" on the Yukon River.
>
> In 1972, coarse gold was discovered for the first time in the territory at Sayyea Creek. The deposit was not rich by the standards of the day: four men worked 115 days to recover 77 ounces of gold. At the same time, other parties prospected on the Frances, Yusesyu, and Hyland Rivers, but found no viable deposits. McQuesten and Mayo built a trading post at Fort Reliance, five miles downstream from the present Dawson City that year.
>
> Access to Yukon was made easier in 1880, when the Chilkat Indians were persuaded to allow prospectors to cross the Chilkoot pass. Between 1880 and 1887, prospecting activity increased. Numerous "bar" deposits were found on the Yukon, Teslin, and Steward Rivers. Near the end of 1886, coarse gold was found on the Fortymile River. In 1887, there were more than 300 miners on the Fortymile, and bar miners were busy in other areas as well. The mining industry in the territory was finally firmly established.
>
> Veteran prospector Robert Henderson arrived during the summer of 1894. Finding the Fortymile and Sixty Mile Rivers too crowded, he decided to prospect the Indian River. He systematically prospected the Indian and its tributaries in 1894 and 1895. He was not the only prospector exploring new territory: in 1895 miners working their way up the Stewart and McQuesten Rivers discovered gold on Haggart Creek.

1/Yukon River Basin Study Project Report, [4], pp. 4-5.

Henderson spent the winter of 1895-1896 working on Quartz Creek. Meanwhile, 350 miners were active on Miller, Glacier, and Bedrock Creeks. During the summer of 1896, Henderson made a trip to Ladue's post at Ogilvie for supplies. The water in the Indian River was low, and he knew it would be almost impossible to proceed up the stream, so he went down the Yukon to its confluence with the Klondike. There, he found George Carmack and two Indians, "Shookum Jim" and "Tagish Charlie," who were fishing for salmon. In accordance with custom, Henderson announced a discovery he had made at Gold Bottom Creek, and invited Carmack, but not the Indians, to stake on the creek.

Carmack reluctantly promised to visit Gold Bottom Creek, as he was more interested in logging than in prospecting. Skookum Jim saw colours in Bonanza Creek near Sourdough Gulch on a trip to look for good trees, but Carmack was not influenced by Jim's enthusiasm. A few weeks later, however, he decided to visit Henderson and do some prospecting. Their visit was a disappointment, and Carmack, Jim, and Charlie returned to Bonanza Creek. There, on August 16th, they decided to stake.

The trio proceeded to Forty Mile to record their claims. When news of the discovery became known to the miners in the Forty Mile district, they all stampeded to Bonanza Creek. Within 3 months, 500 claims were staked. Extensive prospecting commenced, and in a few months the remarkable wealth in the gravels of Bonanza and Eldorado Creeks were revealed.

It was almost a year before news of the strike reached the "outside." When it did, thousands of gold seekers immediately started for the Klondike, and the "Klondike Gold Rush" was on.

Mining procedures to about 1901 were labour-intensive. The cost of bringing machinery 4,000 miles by steamship precluded its use. Heavy machinery became available in 1900 when the White Pass Railroad was completed to Whitehorse. With the exception of a small steam dredge put into production on Cassiar Bar below Hootalinqua in 1898, however, dredges did not appear in the territory until 1905.

While the Klondike area held the attention of the mining fraternity and the general public, the prospectors were not idle. In 1896, Jack Dalton found gold in the Dezadeash area. Gold was also found that year in Johnson Creek, a tributary of the McQuesten River. In 1898, Scroggie, Baker, Henderson, and Clear Creeks were discovered. Duncan Creek and Dublin Gulch in the Mayo area were found, Hayes Creek in the Dawson Range was found, and Alder Creek in the Dezadeash area was found. Additional discoveries were made each year to 1905, and have been made sporadically since then.

The dredges and hydraulic mining operations in the Klondike were the mainstay of the territory's economy between 1900 and 1933. Then in January, 1934, the U.S. government set the price of gold at $35.00 per ounce, almost double the existing price. A new wave of prospectors rushed to the Yukon.

Mining activities were reduced with the outbreak of war in 1939. By the end of the war, bulldozer mining had become common, but the cost of labour and supplies had rised to the extent that most of the creeks could no longer be mined profitably. Gold mines in all areas of Canada were closing by the end of the 1940's when the federal government introduced a subsidy on gold production. Most placer mines in the territory took advantage of the subsidy until the rise of the gold price in the early 1970's.

In the mid 1960's, most placer operations ceased. Even Yukon Consolidated Gold Corporation shut the last of its dredges in 1966. A handful of miners continued to work, but most operated on a very small scale.

The rising price of gold in the early 1970's created new interest in placer mining. As the price continued to increase in the late 1970's, staking and mining activity increased accordingly. Activity peaked in 1980 and 1981, and then slumped in 1982 after significant declines in the price of gold during 1981 and 1982."

Between 1978 and 1981 the quantity of placer gold mined in the Yukon rose from 581 thousand grams to 3.1 million grams in response to the rapid runup in real gold prices which occurred during this period.[1/] Gold prices began to fall in 1981 and continued their decline during most of 1982. In real terms measured between annual averages (average of 52 weekly quotations from Metals Week [16]), gold prices fell by 33.3 percent in 1981, and by a further 26.2 percent in 1982. Through late September 1983, real gold prices had risen only 4.4 percent over the 1982 annual average.

According to Debicki the number of placer leases in good standing in the Yukon declined by nearly 50 percent in 1982 from the 1981

1/See Yukon Exploration and Geology, 1981 [9C] for quantity estimates, Table I, p. 4. Recent price history is given in our Table 4 , above.

high.[1/] Her count of 650 placer mining employees in 1982, down from 781 in 1981, may understate the decline on a year-round-full-time basis if placer leases were, on average, operated for fewer weeks during 1982 than during 1981. Her estimated 1982 decline in placer gold production of 25.7 percent suggests a greater employment decline than is shown by the drop in "counted" employees.[2/]

In order to estimate the statistically average historical response of placer gold production to price changes, we estimated the following equation over the period 1968 to 1982 (annual) using the method of ordinary least squares.

$$\begin{aligned} GOLDPYK = {} & -257211 + 2661.1*PGOLDNY/(XRTE*CPI) \\ & (-3.7) \quad (3.6) \\ & + 3868.8*PGOLDNY(-1)/(XRTE(-1)*CPI(-1)) \\ & \quad (3.3) \\ & + .35*GOLDPYK(-1) \\ & \quad (2.1) \end{aligned}$$

$\bar{R}^2 = .980$
DW = 1.205
t - statistics in parentheses

where GOLDPYK - Debicki's series on placer gold production (grams)
PGOLDNY - The New York U.S. dollar spot price of one ounce of .999 fine gold
XRTE - The U.S. dollar price of one Canandian dollar (spot)
CPI - The Canada CPI, 1971 = 1.000

The equation states that a $100 increase in the real, exchange rate adjusted price of gold initially raised placer gold production by 266,110 grams (YEAR 1). If the price increase held for three years, second year production would have risen by 746,128 grams, and third

1/[7], p. 74.
2/Debicki's estimated 1981 placer gold production is 2.5 million grams. This is smaller than the estimate of 3.1 million grams given in [9C]. Debicki's 1978, 1979, and 1980 figures also differ from those in [9C]. The differences are due to the adjustment for fine gold content reflected in [9C] but not in Debicki [7].

year production by 914,135 grams. If sustained indefinitely, the annual increment to placer gold production would have exceeded one million grams.

Given absolute limits on Yukon placer gold production (Debicki's figures show maximum production of 33.5 million grams in 1900, but a ceiling of 3 million grams since 1920), the equation cannot be depended upon to accurately predict the response to enormous increases in real, exchange-rate adjusted gold prices. (The price on this basis peaked at $339.98 in 1980, and averaged $174.64 in 1982.) However, it can lend insight into the impact of more normal price changes.

If Debicki's figure of 781 placer mining employees in 1981 is correct, then in 1981 the ratio of counted employees to placer gold produced stood at .00031. Assuming this ratio holds, a $100 sustained increase in the real, exchange-rate adjusted price of gold would increase the employee count by 341 in the long run. Adjusted for seasonality of employment, the job gain would amount to something between 175 and 250 full-time annual average equivalent jobs each year. In a later section we will discuss the multiplier effects of such increases in mining employment.

Tungsten

According to [30A], commercially important tungsten deposits in the Yukon Territory are Mactung (Macmillan Pass), Stormy Mountain (near Ross River), Bailey (near Watson Lake), Cab (near Faro), Logtung (near Teslin)

and Ray Gulch (near Elsa). Grading 1.02 percent wolframite and estimated to contain 12.3 million tonnes of ore, the Mactung deposit is considered the most likely to go into production in the near future. Mactung compares favorably to the nearby Cantung deposit in the Northwest Territories (1.5 percent wolframite, 3.2 million tonnes of ore).

The principal problem faced by tungsten producers is how to reverse the steady decline in real and nominal prices that has been underway since the 1977 upward price surge. After rising 36 percent in 1977, real tungsten prices have fallen every year since, and stood at a level some 70 percent below their 1977 average as of early August 1983. (See Table 4, above.) Much of this price decline can be attributed to continuing sales by the U.S. government from its stockpile of tungsten concentrate. The unexpectedly deep Worldwide economic recession of 1982 contributed to a further decline in tungsten prices.

If World tungsten demand gets back onto the 3.5 percent annual growth track projected by the U.S. Bureau of Mines in 1980 [18], real tungsten prices can be expected to rise. Should real prices achieve 1980 levels (some two times current real prices but still some 33 percent below 1977 highs), projects such as Mactung could be at or near breakeven. We hedge this statement only because we are not privy to the details of the Mactung cost structure.

The possibility of rapid increases in tungsten prices over the next year cannot be excluded. We say this for three reasons.

(1) There is a possibility of a stronger than expected economic recovery in the O.E.C.D. countries.

(2) A slowing down of sales from the U.S. stockpile could occur as stocks grow closer to desired levels.[1/]

(3) A sharp contraction in mine output took place this year with the closing of some 90 percent of U.S. ammonium paratungstate capacity, the closing of Cantung operations, substantial reductions in Chinese and Siamese exports, and cuts in production in Korea, Bolivia, and Australia.

Barite

As far as the Yukon is concerned, the potential for barite production turns on oil and gas well drilling in the Canadian Arctic. According to [30A], Yukon Barite's TEA project is the only barite operation in the Territory which is near startup, and requires an estimated workforce of only eight (8) persons. Under these circumstances, the mineral's job creating potential in the Yukon cannot be said to be significant at this time.

Molybdenum

Molybdenum prices soared in the late 1970's in response to classic demand pull pressures. In 1977 the United States stockpile of

1/Purchases for the U.S. stockpile were begun during the Korean War and ended in 1959. Sales began in 1965. Currently the U.S. stockpile of tungsten concentrate stands at 86 million pounds. The current goal is 55 million pounds. Only 56 million pounds is considered "stockpile grade." (per Robert Bottge, U.S. Bureau of Mines, Juneau)

molybdenum was entirely depleted and could no longer be used to exert a stabilizing influence on markets. Average molybdenum prices (Metal's Week, dealers' oxide) tripled in 1978, and held near that level in 1979 before declining substantially in 1980. As of early August 1983, prices adjusted for general inflation (see Table 4, above) were only about forty percent of the 1977 level. Indeed, average real molybdenum prices in 1981, 1982, and 1983 have set post-World War II lows. In nominal terms, the August 8, 1983 price (U.S. $/LB) of $4.00, equalled the 1977 average.

Molybdenum is still in excess supply as of September 1983 and several major new mines are waiting to come on stream (Cyprus Mine's Thompson Creek open-pit in Idaho, U.S. Borax' Quartz Hill operation near Ketchikan, Alaska, Molycorp's Goat Hill in New Mexico). In February 1983 Amax, the World's largest producer of molybdenum, indefinitely suspended production at it major mines.

Demand can be expected to resume growing now that the World economy has moved into the recovery stage. However, given present capacity and the potential at new primary operations (Quartz Hill will be the first or second largest operation in the World), it seems unlikely that potential Yukon producers could come profitably on stream before the early 1990's. At the present time, the Adanac prospect just north of Atlin, British Columbia, is rated in [30A] to have the Yukon's best chances of moving into production.

MINING'S IMPACT ON YUKON ECONOMY

Mining directly impacts the Yukon economy in three ways: (1) di-

rect employment, (2) purchases of goods and services from Yukon firms, and (3) induced government activity such as the presence of certain Federal and Territorial employees. In turn, these direct impacts lead to secondary impacts when workers respend their income in the Yukon, or when Yukon firms or agencies directly servicing the mining industry buy goods and services from other Yukon firms, or, finally, when traditional government services are required by persons and firms working in or servicing the industry. To the extent firms in the mining industry or in mining support industries purchase goods and services outside the Yukon, the ultimate job and income creating effects of mining activity are reduced.

One method of measuring the impact of a given industry on a regional economy is to simply read off the relevant multipliers as calculated by a well-specified input-output model.[1/] A multiplier is the ratio of the total change (direct and induced) in some variable of interest, say, personal income, to the change in some other variable, say direct wages paid by the mining industry, which is presumed to have produced the change in the first variable.

A separate study conducted by Midwest Economic Research and Development Ltd. for the Yukon River Basin Study Committee involved the

1/Input-output models laboriously track individual and business spending throughout the economy and then add up the dollars of income generated by, say, and extra dollar of purchases of good X by industry Y. They approximate reality by dealing in statistical averages and by imposing the assumption that production technology is linear, constant returns to scale for all industries. For a technical description, on can read Leontief [14] or any of scores of other good textbooks.

construction of an input-output model for the Yukon.[1/] Multipliers calculated from this model suggest that for every dollar of after-tax wages and salaries directly paid to placer miners, ninety-one cents in such income is ultimately created elsewhere in the Yukon.

Although there is reason to believe that this multiplier may be on the high-side (the model may assume too little in the way of spending leakages outside), it is not out of line with multipliers which can be produced by the new Yukon econometric model. The latter show that an additional 100 new mining jobs sustained for ten years can lead to the creation of 160 other jobs, if government spending is sufficiently population sensitive. With Yukon mining wages per worker up to 50 percent higher than in other Yukon industries, the economic model's multiplier for the mining industry implies that approximately one dollar in Yukon income is created outside the mining industry for every dollar directly paid in wages or salaries.[2/]

If one forces the econometric model's projections of federal spending in the Yukon to not respond to population growth induced by the assumed 100 new mining jobs, the new Yukon econometric model projects that (after ten years) only 101 new jobs will be created outside the mining industry for every new job created within it.

1/"Input-Output For the Yukon," [27B].
2/Wages per worker by industry calculated from industry payroll data in the Territorial Accounts [9A] and employment data in [30B].

This difference in sensitivity (160 versus 101) is not solely a mathematically curiousity. While it seems unlikely that the federal budget in the Yukon would be responsive to small population changes, it certainly could be expected to be sensitive to large population changes. Where the line between "large" and "small" population changes should be drawn is unclear. (Certainly 5000 is large, but is 500?) However, one would probably be correct if one presumed that larger development projects produce proportionately more jobs than smaller projects and that, dependent on project size, for every 100 new mining jobs created and maintained something between 100 and 160 new jobs would be created outside the mining industry, after ten years. Furthermore, one can expect mining jobs to have relatively more secondary job creating power than, say, jobs in tourism, because mining jobs pay relatively high wages and, therefore, generate more in-Territory spending of wage income per job, than jobs in lower paying industries, all other things equal.[1/]

TOURISM

The best available statistical description of the Yukon tourist industry that we know of is Yukon Tourism Highlights 1982, published by the Tourism Planning and Development Branch of the

1/Average annual payroll per job, 1978 as calculated from data in [9A] and [30B].
Mining - $22,345
Services - $11,108
Federal Government - $14,414
Transportation, Communications, Utilities - $11,196
The year 1978 is the most recent for which payroll data by industry were available in the Territorial Accounts, at this writing.

Yukon Department of Tourism, Heritage and Culture. Data and information in this report are compiled from interviews with tourists and obtained from companies and individuals doing business with tourists. A "tourist" for purposes of the present report is defined to be a non-resident who crosses the Yukon border, be it for purposes of business, pleasure or some combination of the two.

By this definition, the number of tourists visiting the Yukon is estimated in the 1982 Highlights to have risen from 270,897 in 1972 to 365,057 in 1982, and to have reached a high of 386,772 in 1981. Growth in this number between 1972 and 1982 averaged 3.0 percent per year.

Spending is estimated to have been a rather modest $139.70 per visitor in 1982, and to have totaled $51 million. Judging by this figure, the great majority of visitors to the Yukon are only passing through, presumeably on the Alaska-Canada Highway or as part of a whirlwind package tour. Indeed, adjusted for inflation (stated in 1976 dollars), estimated gross tourist expenditure has fallen from $32.9 million in 1972 to $25.2 million in 1982; and in per capita terms from $121.75 in 1972 to $68.92 in 1982.[1/]

The new Yukon econometric model, NEWYEM, allows one to estimate the job creating power of tourist expenditure in the Yukon. Based on a special simulation of this model, it takes about 220 addition-

1/Figures in this paragraph are obtained from Highlights [31], p. 33, and are adjusted for inflation using the Yukon CPI defined in [23B]. The Yukon CPI (1976 = 1.000) stood at 0.660 in 1972 and had risen to 2.027 in 1982.

al tourists every year to create one new job in the Yukon. At the estimated 1982 rate of spending per tourist ($139.70, see above), this translates into approximately $31 thousand in tourist expenditure to create one year-round, full-time equivalent job. If this is true, then approximately 1,650 such jobs in the Yukon existed in 1982 because of the tourist industry, or about 15 percent of combined wage-salary and self employment. Given the seasonality of the tourist industry, one year-round, full-time equivalent job translates into approximately two workers employed for approximately six months apiece.

From the point of view of economic policy, ultimately it is tourist spending that creates jobs. Total expenditure by tourists can be increased either by encouraging more people to visit the Yukon or by inducing visitors to spend more per visitor while in the Yukon. Judging by the 1972-1982 decline in real expenditure per tourist cited above and the corresponding rise in the number of visitors, policy to date may have focussed disproportionately on increasing the number of tourists. It may be time to concentrate on ways to increase real spending per tourist.

GOVERNMENT

In 1978, the most recent year for which Territorial Accounts data were available at this writing, the federal government spent in the Yukon approximately $124 million on current account, $31 million on capital account, and loaned $82 million to the Territorial government and to private individuals and businesses. Of

the $124 million in current account outlays, some $71 million was a direct transfer to the Territorial government, and some $1.2 million a direct transfer to local governments. The $71 million transfer to the Territorial government represented approximately 75 percent of total Territorial government revenue including loans in that year, a percentage well in line with the historical average.

In 1982, direct government employment as a percentage of total wage-salary employment stood at (see Table 3, p. 13) 14.9 percent (federal), 22.6 percent (Territorial), and 2.3 percent (local). With the federal government supplying approximately 75 percent of the Territorial government budget, about 30 percent of all jobs in the Yukon were either directly provided by the federal government or financed via transfers to the Territorial government and local governments. In 1982, we estimate that federal government provided or financed over one-half of all the basic industry jobs in the Yukon.[1/]

In a trial simulation of the NEWYEM econometric model, a $100,000 sustained real increase in federal government expenditure of an historically "average" composition produced approximately four new Yukon jobs. If one recalls that the model's estimate of tourist expenditure power suggested a figure of $31,000 per job created, one

1/

Federal Government	3,021 jobs	
Tourism	1,650 jobs	(See the previous section)
Mining	1,080 jobs	(Includes some "self-employed" from Table 1)
Total Basic Sector	5,751 jobs	
Total Jobs In Yukon	11,114	(See Table 1)

might wonder why only about $25,000 in federal expenditure is required to create one job. In part, the reason has to do with the fact that a relatively high percentage of each federal dollar goes directly for wages and salaries (about 35 percent counting the portion of federal transfers to other governments which is so spent), or for purchases of services.

Based on a U.S. Internal Revenue Service sample of firms in each industry, the following percent of each dollar of business receipts went to "purchases" other than investment goods:[1/]

Retail Trade	69.7%
Wholesale Trade	72.1%
Transportation	9.4%
Utilities	3.6%
Services, All	9.2%
Hotels & Lodging	10.9%
Finance, Insurance, & Real Estate	3.6%
Construction	18.8%

A dollar spent directly on wages and salaries has more in-Yukon job creating power than a dollar spent at, say retail, because 100 percent of the wage dollar is income, and is available for respending in the Yukon, whereas something on the order of 50 percent to 70 percent of a dollar spent at retail immediately leaves the Yukon to purchase materials for resale.[2/]

1/The figure should be similar for Canadian firms. Source: U.S. Internal Revenue Service [13].

2/The figure is 50 percent if the retailer buys from a Yukon wholesaler, and 70 percent if the retailer buys from outside. By more detailed industry the purchase percents for retail trade (same source) were: Grocery Stores - 80.9%; New & Used Cars - 78.4%; Apparel & Accessories - 64.9%; Eating/Drinking Places - 44.7%; Drug Stores, etc. - 67.8%.

It can be shown that under certain simplifying assumptions, the amount of in-Yukon income generated by a dollar of spending should equal g/(1-s), where "g" is the portion of a dollar of initial expenditure spent in the Yukon, and s is the fraction of each dollar of income respent by subsequent recipients in the Yukon. If g is higher for a federal expenditure dollar than it is for a tourist dollar, then the federal expenditure dollar will generate more Yukon income than will the tourist dollar and more Yukon jobs, assuming s is roughly the same in each case.

Undoubtedly, some statistical error could account for a portion of the apparent extra job-creating power of a federal expenditure dollar. However, the error may be in the opposite direction! If for example, the federal government raised payrolls by $25,000, it could hire approximately one extra person year of labor at estimated 1982 wages. If in turn, the true job multiplier for federal employment were a conservative 1.6 (.6 jobs extra created for every one new federal job), then ultimately the $25,000 expenditure would create 1.6 year-round, full-time jobs.[1/] To create 1.0 such jobs would then require $15,625 in payroll expenditure. Of course, not all federal expenditure is for payrolls.

1/The 1.6 job multiplier was not estimated from NEWYEM but is consistent with multipliers estimated for other regions.

SUPPORT INDUSTRIES

For purposes of this report, "support" industries are those for which product demand is (largely) local in origin. These industries include construction, communications & utilities, transportation, services/trade, Territorial government, and local government. If Yukon employment were zero in mining, travelers never visited the Territory, and the federal government spent nothing in the Yukon, then activity in the support industries would essentially cease and the economy revert to subsistence. This is the sense in which the basic - support dichotomy is offered. A minor definitional problem arises with the recognition of tourism as a basic industry. At least some part of the services, trade, and transportation sectors must be classified as basic on the grounds that some percentage of production in these industries supplies nonlocal demand.

A support sector phenomenon of particular importance in developing economies such as Yukon (and Alaska) is "deepening." As an economy develops, both support sector expansion and support sector deepening takes place. The latter concept refers to the process whereby new goods and services are provided locally, and whereby per capita increases occur in the availability of goods and services already provided.

Examples of support sector deepening which have occurred and which are likely to continue to occur include the establishment of spe-

cialized retail and service sector operations such as tobacco stores, hobby shops, and fast food outlets; a per capita increase in the availability of professional services such as those of doctors, lawyers, accountants, economists, and engineers; and increased availability of public services per capita such as police, fire, and transportation.

Support sector deepening brings growth in the support industries over and above that which is attributable by historical relationships to growth in the basic sector. Despite the apparent decline in real tourist expenditure cited above, and a cyclical 1982 drop in mining sector employment, Yukon employment per capita over the period 1972 to 1982 nevertheless rose 12.6 percent in communications & utilities, 23.6 percent in services and trade, and 41.2 percent in local government.[1/] Indeed, with the exception of construction and transportation (which suffered a severe loss in employment in 1982 when the Whitepass-Yukon railroad suspended operations), ten year growth rates in support sector employment exceeded the all-economy average ten-year growth rate of 29.7 percent rather markedly, posting the following gains:

Communications & Utilities.....43.0 percent
Services/Trade.....57.3 percent
Local Government.....80.5 percent

With the Yukon economy still readily classified as "developing," there is every reason to expect further support sector deepening in the future.

1/Based on figures in Table 2 and 3, above.

III. FOUR VIEWS OF YUKON'S FUTURE

As long as real federal spending in Yukon does not decline precipitously, there appears to be little chance of a catastrophic collapse in the level of Yukon employment, population, and economic activity in general. Even if real per capita federal spending were to decline 3 percent per year, the number of tourists to grow only 1.5 percent per year, and hard rock mining activity other than exploration to cease altogether, the Yukon population might still exceed 20,000 persons at the turn of the century. Conversely, should tourism federal government, and mining activity all boom for twenty years, it is possible that the Yukon population would grow to about 70,000 persons by the year 2003.

In this chapter we discuss why we believe Yukon's long term economic prospects (year 2003) can be bracketed in this manner, and how certain policy alternatives can be expected to affect the ultimate outcome. The conclusions expressed here are based on four simulations of Yukon economic activity through the year 2003 made with the NEWYEM econometric model. The assumptions that drive these simulations, both those embodied in the model's equations and those imposed in the form of specific settings for the model's exogenous variables, are heavily influenced by professional judgement, in turn guided by an analysis of metals markets, the Yukon tourist industry and the overall structure of the Yukon economy.

- TWO METHODOLOGICAL CONSIDERATIONS -

(1) WHAT IS MEANT BY "HIGH?"

Some of the responses to an earlier draft of this report made it clear that terms such as "HIGH" and "LOW" were not universally understood, with respect to their use in characterizing the four simulations of Yukon economic activity which are to be discussed in this chapter. In particular, what was not well understood is that the "HIGH" growth alternative does not describe the extreme of what is possible, but rather represents a scenario, which if characterized in terms of employment growth, would lie (roughly) at the judgemental 90th percentile of the analyst's subjective probability distribution of possible outcomes. In effect, by labelling a simulation the "HIGH GROWTH" alternative, we are saying that in our judgement, there is not more than a 10 percent chance of employment growth exceeding that which is projected over the forecast period. Similarly, the "NEGATIVE GROWTH" alternative presented below does not represent the extremes possible at the low end of the employment growth scale, but rather in our judgement is an outcome that has no worse than a 10 percent change of ultimately proving to be optimistic.

This definitional standard is adopted because experience teaches one to be conservative. Given a set of potential development projects (say, mine openings), all of which are presently viewed as equally likely to come on stream, we believe that some of them

will not do so, even if we cannot now predict which will not. If nevertheless all of the projects were to be included in the "HIGH GROWTH" simulation, we would be guilty of overstating what is reasonably achievable. This is why it is important that one not judge the reasonableness of each simulation's assumptions so much on the individual events assumed to occur, as on the totality of the picture which is painted. Recalling elementary probability theory, one notes, for example, that if there are six potential projects that each have a 60 percent chance of being done, that there is only a 4.7 percent chance that all of them will be done.[1/]

(2) TRENDS NOT PRECISE PATHS.

A forecaster may feel very confident about where an economy is heading, while at the same time being extremely unsure of the precise path which will be followed in getting there. The economics profession has great difficulty predicting cyclical economic turning points one quarter ahead, and is hopelessly ill-equipped to foretell cyclical gyrations over a twenty-year period. In this report we do not even try. The precise timing of events in each of the four simulations presented below should not be viewed as a confident prediction. Emphasis has been placed on getting the major trends "right," and not on the hopeless task of divining every movement along the way.

1/Assuming their probabilities are independent, the chance of all six being done is $(.6)^6$ or 0.0466. If each has an independent 90 percent chance of being done, the probability of all six being done is $(.9)^6$ or .53!

- DEFINING ASSUMPTIONS -

We begin with a formal presentation and discussion of the economic conditions which, in effect, define each of the four model simulations which were performed. Econometricians who choose to familiarize themselves with the structure of the NEWYEM forecasting model used in preparing the simulations, will recognize these as assumptions which set the 1983 to 2003 growth pattern of the model's exogenous (driver) variables.[1/]

The four simulations performed for this study have been labelled BASE CASE, HIGH GROWTH, LOW BUT POSITIVE GROWTH, and NEGATIVE GROWTH. The simulations themselves are presented in Tables 6BC, 6HI, 6LBP, and 6NEG (below). Their defining assumptions are given in the next four sub-sections.

BASE CASE

1. Real lead prices rise an average of 15 percent per year until 1987, and 1 percent per year thereafter; and real zinc prices rise an average of 10 percent per year until 1987, and 1 percent per year thereafter. This implies that United Keno Hill (Elsa) reopens in 1983 and remains open through the 1988 season (when presently estimated reserves are exhausted), and that Cyprus Anvil (Faro) reopens in 1986 and remains open until 1994. This assumption is based on three key considerations.

   (i) the fact that real lead prices have continued to fall in 1983 (down 31% in August from the 1982 average) while

1/See [23B].

other real prices for metals have stabilized;

(ii) the belief that recovery in the OECD countries is well underway.

(iii) the conclusion that because of (i) and (ii) real lead prices will rebound relatively sharply for a period but (for the structural reasons discussed above) will not regain previous highs as rapidly as will other metals prices. Under this assumption real lead prices approach the 1981 level in 1987 and real zinc prices reach a new annual average high in 1986. See Table 4 for historical price data.

2. Real tungsten, molybdenum, and copper prices return to 1980 levels in 1987 and rise 1 percent per year thereafter. The Mactung deposit goes into production in 1987 and continues operation through year 2003.

This price assumption is consistent with the observations offered in the previous chapter. If tungsten, molybdenum and copper supplies are to be forthcoming at the rates necessary to satisfy projected long term demand (see Table 5), price increases of at least this magnitude will be required. In 1980 the annual average real dollar price of tungsten was 2.15 times the price posted in August 1983. In turn, however, the 1980 real price was still one-third lower than the 1977 price.

3. Real gold and silver prices rise 1 percent per year 1983 to 2003 with attendant increases in placer mining operations. This is simply a trend projection, and one which is held with

no great conviction. A 1.0 percent annual average real price increase coupled with a 5.0 percent inflationary gain per year (roughly the present consensus for North American inflation) implies that nominal gold prices will once again hit the $800/ounce mark (U.S. dollars) in approximately eleven and one-half years.

4. The number of tourists (border crossings) grows at an annual average rate of 2.5 percent, the 1974 to 1981 average, over the 1983 to 2003 period. Because real per tourist expenditure is assumed to remain constant, the assumption is equivalent to letting real total tourist expenditure grow at an annual average rate of 2.5 percent. This assumption was chosen for the BASE CASE because extrapolating recent experience appears reasonable in light of the determination of the Yukon Visitors' Association to generate more tourist travel and to stem the historical decline in real per tourist expenditure. Indeed, Yukon Visitors' Association believes that somewhat more rapid growth in the number of tourists should be assumed in the BASE CASE. At the time the Association's comments were received, however, it had not been made clear that constant real per tourist spending would also be assumed, a factor which in light of the apparent long term decline in real tourist expenditure recorded in Yukon Tourism Industry Highlights, 1982 [31], could be said to respond to the Visitors' Association concerns.

5. Real per capita federal spending in Yukon remains constant. According to Yukon Economic Accounts [9A], real per capita federal spending on current account rose 2.4 percent per year

between 1967 and 1978, the last year for which the comprehensive data were available at this writing. Between 1978 and 1982, a change in trend may have occurred. During the last four years federal government employment in Yukon rose only from 1,373 jobs to 1,414 jobs (Table 3). This suggests a slowdown after 1978 in the rate of growth of federal spending unless major compositional changes also occurred. In light of the fiscal conservatism which appears to be surfacing in the Country (manifested by the rising popularity of Mr. Mulroney), a return to the 1967-1978 pattern of steady real per capita spending increases seems unlikely.[1/] On the other hand, yearly cuts in real per capita spending also seem unlikely, given the traditional federal concern for populating the North, and the relatively small size of total federal spending in the Territory, (in fiscal 1982, approximately $260 million of a total federal budget of approximately $20 billion).

6. Real government investment spending rises 2 percent per year. Between 1978 and 1982 real government investment spending rose an average of 8 percent per year.[2/] Since the BASE CASE population rises approximately 1 percent per year, this implies about a 1 percent per year increase in real per capita government investment (all governments). This assumption is less a

1/One could add also the comeback of Robert Bourassa in Quebec, riding a conservative economic platform. The changing political winds are unlikely to be ignored by the Liberal Party even should it retain office in Ottawa.
2/See [9A], Table 4. Deflated by Yukon CPI [23B].

judgement of future probable trends than it is an input specified so that readers and policy makers understand the context of the simulation. However, see the section on Public Sector Capital Requirements, below.

The remaining three BASE CASE assumptions are simply extrapolations of recent trends and conditions and should not be viewed as confident predictions.

7. National population grows (1983 to 2003) at an annual average rate of 1.2 percent, the 1974 to 1981 average.

8. Real per capita Canadian disposable income grows (1983 to 2003) at an annual average rate of 0.6 percent, the 1974 to 1981 average.

9. The U.S.-Canada currency exchange rate holds at its present level.

HIGH GROWTH

In our judgement, the assumptions upon which the HIGH GROWTH simulation is based, when viewed alongside the BASE CASE assumptions define a confluence of events which a reasonable observer would term "optimistic" but not out of the question. Indeed, the assumptions were presented to a group of knowledgeable observers and were viewed in this light. The LOW BUT POSITIVE and NEGATIVE GROWTH assumptions were also reviewed by the group. The HIGH GROWTH assumptions are:

SAME AS BASE CASE EXCEPT:

H1. Real gold and silver prices rise 2 percent per year 1983 to 2003, with attendant increases in placer mining operations.

H2. The United Keno Hill mine (Elsa) continues production through year 2003.

H3. The Tom and Jason lead, zinc, silver operations commence milling in 1990 at a combined 9,000 tons per day and operate through 2003.

H4. The number of tourists grows at an annual average rate of 7.5 percent per year 1983 to 2003. Real per tourist expenditure remains constant.

H5. Real per capita federal spending in the Yukon grows 0.6 percent per year 1983 to 2003.

H6. Real government investment spending rises 4 percent per year 1983 to 2003.

H7. The Alaska-Canada natural gas pipeline is constructed during the 1987 to 1990 period and operates at capacity 1991 to 2003. The construction workforce (Yukon) peaks at 4,000 in 1990. Permanent pipeline employment in the Yukon is 150 1991 to 2003.

LOW BUT POSITIVE GROWTH

SAME AS BASE CASE EXCEPT:

LBP1. No hardrock mining operations in Yukon through 2003, other than exploration.

LBP2. Real gold and silver prices remain constant 1983 to 2003.

LBP3. The number of tourists grows 1.5 percent per year 1983 to 2003. Real per tourist expenditure remains constant.

NEGATIVE GROWTH

SAME AS BASE CASE EXCEPT:

NEG1. No hardrock mining operations in Yukon through 2003, other than exploration.

NEG2. Real gold and silver prices decline 1 percent per year through 2003.

NEG3. The number of tourists grows 1.5 percent per year 1983 to 2003. Real per tourist expenditure remains constant.

NEG4. Real per capita federal spending in the Yukon declines 3 percent per year 1983 to 2003.

NEG5. Real government investment spending declines 2 percent per year 1983 to 2003.

COMMENTS OF OTHERS

With only minor differences, the four sets of defining assumptions given above were presented to a group of knowledgeable Yukoners at a meeting held in Whitehorse in mid-September 1983.[1/] In general, it is correct to say that the group agreed that the assumptions fairly bracketed prospects for future economic change in the Yukon.

Two of the participants felt that the BASE CASE annual growth rate in the number of tourists (2.5 percent) was too low, and that one might reasonably expect to see as many as one million visitors to the Yukon by the year 2003 (growth rate of 5.1 percent per year). If this came to pass, BASE CASE employment would be about 1,800 jobs greater in the year 2003 than the 15,093 jobs shown in Table 6BC, above.[2/]

A third observor felt that Beaufort Sea oil and gas development might have a very significant job and income creating effect in the Yukon if Whitehorse were used as a staging area. Because in our judgement this would require an explicit federal decision, we have not responded to this comment. (Calgary and Edmonton are likely to remain preferred staging areas for the indefinite future, according to discussions held in the past with oil company officials.)

1/The group included Al Kapty (Trans North Air), Tom King (White Pass & Yukon), Barry Redfern (Yukon Visitors Association), John Ferbey (Yukon Department of Economic Development and Intergovernmental Relations), Glenn Grant (Yukon Department of Economic Development and Intergovernmental Relations), Joe Ganshe (Department of Indian & Northern Affairs), Ron Gourley (City of Whitehorse), Glen MacDonald (Yukon Chamber of Mines), and Pat Dixon (Foothills Pipeline Company).

2/Sum of wage-salary employment (12,926) and self-employment (2,167).

Other comments which were offered pointed out some of the growth inhibiting events which have been occurring or which could occur. Among these were:

1. Cassiar Asbestos supplies backhaul for trucks which deliver groceries to the Yukon. When it closes, the price of groceries will go up noticeably, thus contributing to an increase in the cost of living and of doing business in the Yukon.

2. Spanish American, African, Asian, and Communist countries may continue to inhibit increases in metals prices because of their need for foreign exchange and their willingness and ability to sell below North American costs of production.

3. The debt burden of Dome Petroleum may prevent Dome Mines from ever opening Cyprus Anvil.

Because, in our opinion, the comments which were offered tended not to point to an overall bias in our BASE CASE assumptions, and because the HIGH GROWTH assumptions appeared to all participants to adequately define the high end of what might be termed "judgementally reasonable" expectations, no major alterations to the assumptions were made as a result of the mid-September meeting.

- ASSUMPTIONS NOT MADE -

Certain events which could stimulate economic growth in Yukon have not been explicitly identified in either the BASE CASE or the HIGH GROWTH assumptions. Their omission has caused some concern amongst reviewers of the first draft of this report. The events are: (1) settlement of Yukon Native Claims; (2) use-of Whitehorse as a staging area for Beaufort Sea oil and gas development; (3) additional mine openings (Venus, Prism Resources, Laforma, Tinta Hill, VAL, Midway); (4) the 100+ Yukoners presently working in the Beaufort; (5) oil and gas exploration in Kotanelle and Eagle Plain gas fields; (6) the Peter Kiewit Sons Rock Quarry; and (7) re-opening of the White Pass and Yukon Railroad.

These projects have either (a) been included in one or more simulations but not explicitly identified; (b) been omitted along with others because they are not seen as likely to significantly affect the macro-economic results (i.e. the aggregate pace of activity); or (c) been omitted along with others for probability - theoretic reasons.

YUKON NATIVE CLAIMS

It seems very likely that some sort of settlement of Yukon Native aboriginal claims will be made within the next several years between Yukon Native Indians and the federal government. We expect that the settlement will consist of cash and/or land, and that it will parallel at least in part, the settlement reached between Alaska

Natives and the United States government in 1971. At the present time disagreement amongst Yukon Native groups seems to be delaying a proposed settlement of approximately $200 million. However, it seems likely that a compromise will be reached.

Omission of a Yukon Native Claims Settlement from the simulations offerred here does not, therefore, reflect a belief that such a settlement will not take place. Rather, it reflects a conviction that capital markets are efficient enough to allow one to conclude that most investments (a) that will be made by Yukon Natives in Yukon, and (b) that a reasonable observer would judge to be productive, would (c) have been made by others had a claims settlement never occurred.

The granting of a claims settlement influences investment demand but does relatively little to influence the characteristics of potential investment alternatives. It is certainly true that if Yukon Natives become active investors, that profits from their investments will accrue to Yukoners in instances where they might otherwise go outside. However, this is likely to be something of a second order effect.

It is also true that from the point of view of information availability, Yukon Natives may be initially better informed as to the existence of certain investment alternatives than is anyone else. However, it is hard to believe given such opportunities and no settlement, that the knowledgeable individuals would not seek out financing in any case, and in so doing help their "inside" information become well known.

If Alaska is any guide, one must conclude that the bulk of Native investments will consist of purchases of existing businesses. Sealaska, the largest of the thirteen Alaska regional Native Corporations, purchased Ocean Beauty Seafoods, the Alaska Brick Group of Companies, Pacific Western Lines, and holds stock in United Bancorporation Alaska. Of its ventures only the latter, and the Sealaska Timber Corporation can be viewed as startup investments, and even here the effect has not been wholly incremental. Since 1980 when Sealaska Timber entered the market, its sales of round logs have largely displaced harvests from U.S. Forest Service land.[1/]

One could also note that Yukon Native investments could be timed so as to have a counter-cyclical impact on Yukon's economy. This could be of major benefit to Yukoners, but falls outside the scope of the long term trend analysis offerred here. Furthermore, there are no grounds for supposing that such investments will indeed be counter-cyclically made. Indeed, as is well known, investment has tended historically to behave in an extremely pro-cyclical manner, falling at the start of recessions, and rising strongly once recovery is underway.

Finally, there is the obvious stimulus that would be provided by direct spending of settlement monies in Yukon, however spent. A multiplier analysis conducted for this report and discussed more fully later in this chapter suggests the following (assuming a $200 million cash settlement, as is now on the table):

1/Confirmation of these points is available from the Sealaska Corporation Annual Reports, and harvest totals compiled internally by the U.S. Forest Service, Juneau office.

(a) If the full settlement is spent over a two year period, and if the economy mistakenly assumes that the added stimulus($100 million per year) is permanent, up to 2,500 jobs could be created. However, continuing the assumption, once the funds were exhausted, and the extra stimulus faded, most if not all of the new jobs would terminate.

(b) If the $200 million were invested in securities paying, say, 12 percent per year, and if future inflation averages 5 percent per year, the in-Yukon spending of the annual percent interest receivable over and above that required to retain the real value of the principal, could create up to 140 permanent full-time equivalent jobs.

(c) If a portion of the settlement were to be spent on immediate consumption, a portion "invested" in existing businesses or new businesses that would have been started anyway, and a portion "invested" in securities, permanent job creation would be something less than the 140 jobs cited in (b). In this case, the number of new jobs will depend on the fraction of the settlement held in securities, and the manner in which the interest on the securities is spent (how much spent? in Yukon? outside Yukon?).

Because this study is not focussed on transitory or cyclical phenomenon, and because result (c) is by far the most likely description of just how the settlement will be disbursed, there seems little reason to include the settlements in the specific simulations. That is to say, in our judgement, net job creation is likely to be small with respect to the inherent error in the simulations.

BEAUFORT SEA DEVELOPMENT

As a staging area for Beaufort Sea development, Whitehorse ranks behind Edmonton and Calgary. Cargo air service from either of the latter two cities to the McKenzie Delta can be nonstop direct. Indeed, during the 1979 debate in Alaska over State maintenance of the Alaska Haul Road (Prudhoe Bay to Fairbanks), Sohio and Arco documented a rationally based readiness to abandon the Haul Roal, in favor of additional barge service and direct cargo halls from Edmonton via Hercules (C-130) aircraft.[1/] If Edmonton is attractive as a staging area for Prudhoe Bay, it is clearly even more attractive as a staging area for the Canadian Beaufort.

Under these circumstances, only a direct federal subsidy would encourage the use of Whitehorse for these purposes. Given the well known financial difficulties of Dome Petroleum, the leader in Beaufort development, and the federal government's extensive financial exposure in the Beaufort today, we find it difficult to assume that

1/Dr. Reaume of Alaska Economics, Inc., was, at the time, involved closely in these discussions as Principal Economist for the Alaska Department of Commerce and Economic Development. Specific notes have been lost.

Beaufort Sea development will not be pursued henceforth in as cost-effective manner as possible.

ADDITIONAL MINE OPENINGS

The HIGH GROWTH simulation reflects the following mining activity:

(1) Cyprus Anvil (Faro) runs at full production from 1986 through 1994;
(2) United Keno Hill (Elsa) runs at full production from 1984 to 2003 (end of study horizon);
(3) Tom and Jason open in 1990 and produce throughout the remainder of the study horizon;
(4) Placer mining activity increases 40 percent over the study horizon;
(5) Mactung commences production in 1987, and operates throughout the remainder of the study horizon; and
(6) Employment in exploration grows 17 percent over the study horizon.

Although many additional prospects could be included if one wishes to push the definition of HIGH GROWTH to extremes, in our judgement there is less than a 10 percent chance that mining employment will exceed that which is projected in the HIGH GROWTH scenario, (approximately 2,300 jobs in the mid-1990's, and 2,000 jobs at the turn of the century). The three premises on which this conclusion rests are:

(1) Yukon mines generally are and will continue to be high cost operations, among the last in the World to open and the first to close. Relatively low metal content, high labor costs, and a difficult environment combine to create this problem.

(2) The federal government will not choose to subsidize Yukon mines beyond that needed to reopen Cyprus Anvil, or if it does, the subsidy will be offset by lower spending elsewhere in the Territory.[2/]

(3) The joint probability of N openings, can be reasonably approximated by the multiplicative product of their individual probabilities of opening. Thus, if six mines each have a 60 percent chance of opening, the probability of all six opening is only $(.6)^6$, or 4.7 percent.

YUKONERS WORKING IN THE BEAUFORT

The 70+ Yukoners now working in the Beaufort are included in all of the simulations, but not explicitly mentioned. Increases in this number have not been projected. The multiplier analysis discussed later in this chapter suggests that for every additional $100,000 in disposable income exogenously created (1983 $), and maintained, up to 2.8 new jobs will also be created. If an additional 100 Yukoners

1/By "relatively" low metal content is meant the absence of prospects that have both extensive reserves and a reasonably high metal content per tonne of ore.

2/The Canada Development Corporation (CDC), 48 percent owned by the government, is in difficult financial straits, with $4 billion in debt, $890 million in equity, and a negative cash flow in 1982 on losses of $100 million. This is yet another chastening experience for Ottawa. Source: CDC as represented in BUSINESSWEEK, September, 5, 1983, p. 58.

were employed permanently in the Beaufort and each realized $50,000 per year in disposable personal income from his or her efforts up to 140 additional jobs could be created in the Yukon support sector, and the Yukon population could increase by approximately 100 persons.

KOTANELLE AND EAGLE PLAINS

Oil and gas industry employment is included in "other" in the projections. Because this category of employment either rises (HIGH GROWTH) or remains stable, a succession of projects is implicit. What has not been assumed is any major production. In truth, having already assumed that the Alaska gas pipeline will be constructed, in our opinion a very questionable assumption given pipeline cost and the abundance of additional supplies, we are reluctant to add further optimistic assumptions concerning new gas production.

Should exploration in Yukon produce a major oil find, the simulations could in retrospect prove to have been conservative. However, after twenty years of searching, only 1.25 billion barrels of recoverable oil have been found in the Beaufort/McKenzie/North Yukon region, and this in scattered locations. A recent article in CANADIAN BUSINESS had this to say (July 1983, p. 14):

"Even if vast reserves were proven, the economics and politics of development would remain complicated. Oilmen simply don't know when international prices will recover--although they're certain it won't be this year--and exactly where their markets will be for Arctic production. Beaufort Sea Alliance Executive Director David Brooks, for example, says the ultimate market for oil may be Japan rather than southern Canada. The industry is also braced for the fact that any decision to produce in the Arctic will rest as much on political as economic factors. If Ottawa wants Canadians to have Beaufort reserves, then companies will have to take account of oil and gas prices, royalty arrangements and tax agreements in their own decisions to participate.

If all these concerns can be straightened out, Ottawa and the oil industry will have to deal with what some believe is the thorniest problem in all--satisfying northern people, white as well as Dene and Inuit, that development is in their interests. Pat Shaw, a public affairs adviser for federal lands at Esso Resources, says that northern residents are determined to gain lasting economic benefits from development, as well as protect their environment, and that they're sufficiently organized and politically adept to make sure that happens. "Until these people have it in their minds that development is good," he says, "it won't go ahead."

KIEWIT SANDSTONE QUARRY

The project is small (fewer than 150 year-round-full-time equivalent jobs), uncertain to commence, and uncertain as to permanency. It has been omitted from the simulations. If implemented, its 150 year-round equivalent jobs could ultimately create up to 240 additional support sector jobs elsewhere in Yukon, for as long as the operation continued. (Based on the multiplier analysis presented later in this chapter.)

WHITE PASS/YUKON RAILROAD

The "BASE CASE" and "HIGH GROWTH" simulations show operations commencing in 1985 and returning to 1981 levels in 1986. Re-opening is coincident with full production from Cyprus Anvil (Faro) and United Keno Hill (Elsa). It is worth noting that the company's headquarters is assumed not to move out of the Territory despite the fact that such a move is viewed as a possibility by the Yukon Department of Economic Development according to correspondence received.

- COMPARATIVE SIMULATION RESULTS -

Tables 6BC, 6LBP, 6NEG, 6HI present the four sets of model simulation results. Although the numbers largely speak for themselves, the following highlights may prove more readable. Because the precise timing of most of the events outlined in the assumptions is subject to question, long term compound annual average growth rates and terminal year (2003) economic conditions are best viewed as the defining characteristics of each simulation. The BASE CASE results are those which we view as being most likely to come to pass. One will note that the BASE CASE results are not "midway" in any sense of the word between the results of the NEGATIVE GROWTH simulation and those of the HIGH GROWTH simulation. The reason for this has to do with the conventional algebra of growth from a small base. If major projects do come on stream, they tend to create proportionately larger percentage changes, the smaller the economy in which they take place.

EMPLOYMENT

Average employment growth rates for the 1982 to 2003 period range from a low of minus 1.5 percent in the NEGATIVE GROWTH simulation to a high of 5.5 percent in the HIGH GROWTH simulation; with a BASE CASE growth rate of 1.5 percent per year. Although the year 1983 is nearly completed, from the point of view of data availability it is a forecast year, and is so treated in the simulations. This accounts for the wide range of results shown in the '83 column of the simulation tables.

TABLE 6BC
YUKON ECONOMIC ACTIVITY
BASE CASE SIMULATION
(DOLLAR AMTS IN THOUSANDS)

	'82	'83	'84	'85	'86	'87	'88	'93	'98	2003
POPULATION	24811	24805	25076	25598	26193	26583	26832	27854	28772	30269
LABOUR FORCE	12818	13067	13502	14506	15617	16320	16216	16855	17411	18320
UNEMP. RATE	13.3	13.4	13.4	13.5	13.6	13.7	13.5	13.7	14.2	14.0
EMPLOYMENT	9489	9616	9904	10622	11430	11839	11972	12187	12101	12926
MINING	693	751	823	966	1338	1547	1550	1289	887	906
PLACER	283	292	294	296	298	300	303	314	326	338
EXPLORATION	330	331	340	342	343	349	350	355	362	368
OTHER MIN	80	128	189	328	697	898	897	619	199	200
CONSTRUCTION	582	573	594	743	726	667	659	678	687	723
COMM & UTILS	489	504	518	542	574	601	621	688	745	835
TRANSPORT	678	565	587	640	738	788	791	737	645	663
SERVICES*	3051	3127	3206	3402	3566	3643	3683	3817	3884	4122
FED GOVT	1415	1476	1495	1538	1587	1622	1648	1770	1897	2083
TERR GOVT	2141	2176	2228	2325	2424	2489	2534	2716	2859	3079
LOC GOVT	222	220	225	237	249	254	257	266	261	287
OTHER	218	230	228	229	228	228	229	226	236	228
SELF EMPLOYED	1625	1661	1700	1797	1877	1916	1936	2007	2045	2167
HOUSING STOCK	7442	7434	7515	7838	8253	8474	8556	8329	8576	9226
SING ATTACH	957	975	1004	1065	1141	1192	1224	1292	1433	1652
SING DETACH	4287	4222	4207	4325	4488	4539	4513	4055	3829	3746
APTS & DUPS	1170	1169	1181	1232	1298	1332	1345	1309	1348	1456
OTHER	1028	1069	1123	1216	1327	1411	1474	1672	1966	2378
FED SPENDING	260358	278096	298256	323011	350634	377532	404276	563998	782947	1106940
TERR SPENDING	162536	173279	185902	202627	220928	237949	254585	353002	486025	686414
LOC SPENDING	27233	29143	31580	35311	39203	42447	45493	63178	86356	122918
DISP INCOME	290974	307840	336858	391913	445427	482718	515158	695298	913453	1293840
CONSUMPTION	194145	207634	226990	263389	298821	323668	345344	465833	612059	865492
BANK DEPOSITS	57700	61000	66800	77700	88300	95700	102100	137800	181000	256400
METALS INDEX**	1.938	2.118	2.164	2.185	2.311	2.333	2.355	2.469	2.589	2.715
YUKON CPI***	2.027	2.150	2.281	2.420	2.567	2.724	2.889	3.883	5.218	7.013

*INCLUDES TRADE
**METALS REAL PRICE INDEX,(GOLD,SILVER,LEAD,ZINC,COPPER),1971=1.000
*** 1976=1.000

TABLE 6HI
YUKON ECONOMIC ACTIVITY
HIGH GROWTH
(DOLLAR AMTS IN THOUSANDS)

	'82	'83	'84	'85	'86	'87	'89	'93	'98	2003
POPULATION	24811	24939	25321	25962	26709	27293	34285	41693	48936	61092
LABOUR FORCE	12818	13353	14043	15294	16025	16485	20724	25202	29546	36922
UNEMP. RATE	13.3	13.5	13.5	13.5	12.9	12.5	10.5	10.5	9.9	8.5
EMPLOYMENT	9489	9745	10226	11134	12181	12895	15974	19542	22970	29119
MINING	693	753	828	974	1349	1561	1567	2252	1870	1911
PLACER	283	294	298	302	307	311	316	340	367	396
EXPLORATION	330	331	341	344	345	352	354	364	375	387
OTHER MIN	80	128	189	328	697	898	997	1548	1128	1128
CONSTRUCTION	582	572	602	745	734	703	1849	925	1066	1287
COMM & UTILS	489	512	530	560	600	637	727	1148	1373	1735
TRANSPORT	678	567	593	652	755	812	941	1098	1078	1200
SERVICES*	3051	3153	3302	3568	3818	4005	4982	5864	7149	9207
FED GOVT	1415	1510	1574	1661	1759	1849	2064	2905	3744	5042
TERR GOVT	2141	2228	2337	2496	2670	2819	3267	4543	5786	7678
LOC GOVT	222	222	232	250	268	281	347	430	526	681
OTHER	218	228	228	228	228	228	230	377	378	378
SELF EMPLOYED	1625	1674	1709	1880	2004	2097	2574	3014	3651	4655
HOUSING STOCK	7442	7395	7434	7602	7820	7952	10303	13564	15255	18777
SING ATTACH	957	971	996	1038	1088	1128	1486	2124	2581	3408
SING DETACH	4287	4194	4150	4177	4228	4230	5395	6536	6705	7473
APTS & DUPS	1170	1162	1168	1195	1229	1250	1619	2132	2398	2952
OTHER	1028	1069	1120	1192	1275	1344	1803	2772	3571	4944
FED SPENDING	260358	284217	312365	346677	386054	426935	497233	890389	1471799	2525069
TERR SPENDING	162536	176390	193697	215993	241284	265900	319598	552696	927197	1596981
LOC SPENDING	27233	29505	32727	37351	42400	47182	61176	102427	168091	291004
DISP INCOME	290974	311294	346045	406232	467239	517316	760518	1074120	1636720	2688810
CONSUMPTION	194145	209925	233045	272824	313177	346401	505179	715329	1087730	1781240
BANK DEPOSITS	57700	61700	68600	80500	92600	102500	150700	212900	324300	532800
METALS INDEX**	1.938	2.131	2.193	2.229	2.372	2.411	2.451	2.662	2.892	3.143
YUKON CPI***	2.027	2.150	2.281	2.420	2.567	2.724	2.889	3.883	5.218	7.013

*INCLUDES TRADE
**METALS REAL PRICE INDEX,(GOLD,SILVER,LEAD,ZINC,COPPER),1971=1.000
*** 1976=1.000

TABLE 6LBP
YUKON ECONOMIC ACTIVITY
LOW BUT POSITIVE GROWTH
(DOLLAR AMTS IN THOUSANDS)

	'82	'83	'84	'85	'86	'87	'88	'93	'98	2003
POPULATION	24811	24374	24540	24694	24856	25022	25189	26094	27117	28273
LABOUR FORCE	12918	12266	12477	12655	12842	13035	13224	13856	14725	15720
UNEMP. RATE	13.3	13.1	13.2	13.3	13.3	13.4	13.4	13.6	13.9	14.2
EMPLOYMENT	9489	9165	9288	9384	9485	9589	9694	10209	10766	11373
MINING	693	621	629	631	631	634	634	636	637	639
PLACER	283	290	290	290	290	290	290	290	290	290
EXPLORATION	330	331	339	341	341	344	344	346	347	349
OTHER MIN	80	0	0	0	0	0	0	0	0	0
CONSTRUCTION	582	555	568	573	579	585	591	617	649	679
COMM & UTILS	489	476	487	497	507	517	527	582	644	715
TRANSPORT	678	528	531	533	537	540	542	552	563	574
SERVICES*	3051	2993	3027	3053	3079	3107	3135	3277	3428	3591
FED GOVT	1415	1440	1457	1474	1492	1511	1530	1639	1769	1922
TERR GOVT	2141	2113	2148	2181	2215	2249	2281	2445	2607	2773
LOC GOVT	222	209	213	214	217	219	221	231	241	252
OTHER	218	230	228	228	228	227	233	230	228	228
SELF EMPLOYED	1625	1595	1611	1624	1637	1650	1664	1733	1806	1885
HOUSING STOCK	7442	7357	7356	7349	7350	7357	7366	7395	7764	8185
SING ATTACH	957	964	980	995	1012	1029	1047	1150	1278	1441
SING DETACH	4287	4181	4126	4056	4010	3959	3908	3696	3530	3406
APTS & DUPS	1170	1156	1156	1155	1155	1156	1158	1179	1220	1287
OTHER	1028	1056	1095	1133	1173	1214	1253	1370	1736	2052
FED SPENDING	260358	275421	294030	313756	334892	357515	381680	530523	740074	1036106
TERR SPENDING	162536	170710	181930	193826	206699	220378	234979	325041	451789	630716
LOC SPENDING	27233	28335	30350	32442	34784	37201	39776	55656	78013	109593
DISP INCOME	290974	293056	315303	337479	364034	389791	417078	584804	819581	1149230
CONSUMPTION	194145	197866	212765	227634	245384	262636	280912	393139	550009	769964
BANK DEPOSITS	57700	58100	62500	66900	72100	77200	82700	115900	162400	227700
METALS INDEX**	1.938	2.105	2.136	2.141	2.200	2.205	2.212	2.243	2.275	2.308
YUKON CPI***	2.027	2.150	2.281	2.420	2.567	2.724	2.889	3.883	5.218	7.013

*INCLUDES TRADE
**METALS REAL PRICE INDEX,(GOLD,SILVER,LEAD,ZINC,COPPER),1971=1.000
*** 1976=1.000

TABLE 6NEG
YUKON ECONOMIC ACTIVITY
NEGATIVE GROWTH
(DOLLAR AMTS IN THOUSANDS)

	'82	'83	'84	'85	'86	'87	'88	'93	'98	2003
POPULATION	24811	23076	22989	22920	22861	22806	22751	22504	22297	22125
LABOUR FORCE	12818	11102	10892	10726	10698	10672	10647	10531	10434	10354
UNEMP. RATE	13.3	13.2	13.2	13.2	13.1	13.2	13.4	14.2	14.8	15.4
EMPLOYMENT	9489	8630	8468	8341	8229	8126	8023	7562	7175	6853
MINING	693	621	629	631	631	634	634	636	637	639
PLACER	283	290	290	290	290	290	290	290	290	290
EXPLORATION	330	331	339	341	341	344	344	346	347	349
OTHER MIN	80	0	0	0	0	0	0	0	0	0
CONSTRUCTION	582	542	524	515	507	499	492	457	427	400
COMM & UTILS	489	445	418	405	397	391	387	371	358	347
TRANSPORT	678	519	514	512	511	509	507	497	488	481
SERVICES*	3051	2865	2827	2798	2771	2748	2726	2633	2566	2522
FED GOVT	1415	1311	1273	1237	1203	1170	1139	999	881	780
TERR GOVT	2141	1927	1887	1852	1819	1785	1752	1595	1452	1325
LOC GOVT	222	171	167	164	162	160	157	147	139	131
OTHER	218	229	229	227	228	230	229	227	228	228
SELF EMPLOYED	1625	1533	1514	1500	1487	1476	1465	1420	1387	1366
HOUSING STOCK	7442	7375	7309	7244	7179	7115	7052	6744	6452	6174
SING ATTACH	957	966	974	982	989	997	1004	1037	1065	1088
SING DETACH	4287	4191	4097	4005	3913	3824	3735	3314	2923	2563
APTS & DUPS	1170	1159	1149	1138	1128	1118	1108	1060	1014	970
OTHER	1028	1060	1099	1120	1149	1177	1205	1333	1451	1553
FED SPENDING	260359	262651	268974	275668	282633	289836	297232	337648	384399	438498
TERR SPENDING	162536	163582	167983	172809	178039	183385	188924	220429	259273	307449
LOC SPENDING	27233	27215	28136	29176	30412	31606	32855	40150	49585	51893
DISP INCOME	290974	278237	289420	302588	320412	336044	352393	448365	573563	737882
CONSUMPTION	194145	187843	195429	204329	216287	226831	237857	302559	386898	497487
BANK DEPOSITS	57700	55100	57400	60050	63500	66600	69800	88900	113700	146200
METALS INDEX**	1.938	2.105	2.136	2.141	2.200	2.206	2.212	2.243	2.275	2.308
YUKON CPI***	2.027	2.150	2.281	2.420	2.567	2.724	2.889	3.883	5.218	7.013

*INCLUDES TRADE
**METALS REAL PRICE INDEX,(GOLD,SILVER,LEAD,ZINC,COPPER),1971=1.000
*** 1976=1.000

Government employment as a percentage of total, year 2003 employment is certainly an indication of the type of economy each simulation describes. In 1982, government employment stood at 34 percent of the total. This percentage rises to 40 percent in the HIGH GROWTH case by 2003, but declines to 27 percent in the NEGATIVE GROWTH case. Although one could correctly point out that this is merely the result of the assumptions imposed, an important point would thereby be overlooked. It is necessary to dramatically reduce the federal presence in the Yukon, if one wishes to define "reasonable" assumptions which lead to negative employment growth. In other words, as long as the federal government at least maintains its present per capita commitment to the Yukon, negative growth over the long term is not likely.

INCOME

Changes in the level of real per capita disposable income over a twenty year period are largely caused by changes in the composition of industry in an economy, gains in productivity and changes in the tax structure and in the percentage of the population which is employed. None of the four simulations presented here show very much of a gain in real per capita income over the forecast period. The highest annual average growth rate is that posted in the HIGH GROWTH case, some 0.5 percent per year. This undoubtedly is in large part due to the fact that the critical historical relationships used by NEWYEM to project income growth were estimated over

the time period beginning with 1967. This is just about the time that the U.S. and Canadian economies began to experience very poor growth in productivity.[1/] Should productivity growth improve in the future, gains in real per capita income could be larger than those implicit in the simulation tables. One should be aware also of the fact noted above that between 1974 and 1981, real per capita national disposable income grew only 0.6 percent in Canada.

For the record, real per capita disposable income in the Yukon (1976 dollars) is estimated to have stood at $5,786 in 1982, to rise by the year 2003 to $6,095 (BASE CASE), $6,425 (HIGH GROWTH), $5,796 (LOW BUT POSITIVE GROWTH), and to decline by the year 2003 to $4,756 (NEGATIVE GROWTH). The declining real per capita income in the negative growth case reflects the evaporation of higher paying government, mining, and construction jobs. If growth turns negative, the Yukon is likely to become poorer, both in the absolute and in per capita terms.

HOUSING STOCK

In 1982 the Yukon housing stock consisted of 7,442 units of which 957 (12.9%) were single attached, 4,287 (57.6%) single detached, 1,170 (15.7%) apartments or duplexes, and 1,028 (13.8%) were "other," chiefly pre-built (mobile) homes. On average during 1982, 3.33 persons lived in each occupied dwelling unit.

1/Since approximately mid-1979, value added per employee has declined in Canada. Source: Statistics Canada, Aggregate Productivity Measures, as shown in Diagram 9 of OECD Economic Surveys 1982-1983, Canada [21].

The year 2003 number of persons per house and mix of units for each of the four simulations is given in the following text table.

TABLE 7

HOUSING STOCK CHARACTERISTICS
1982 AND 2003 BY SIMULATION

	1982	HIGH GROWTH	BASE CASE	LOW BUT POSITIVE	NEGATIVE GROWTH
Persons/Unit	3.33	3.25	3.28	3.45	3.58
% Single Attach.	12.9	18.1	17.9	17.6	17.6
% Single Detach.	57.6	39.8	40.6	41.6	41.5
% Apts. & Dupx.	15.7	15.7	15.7	15.7	15.7
% Other	13.8	26.3	25.8	25.1	25.2

In the NEWYEM economic model trends in the composition of the housing stock are not dependent upon economic conditions. As a result, the composition of the year 2003 stock does not vary much across simulations. However, the model does allow the number of persons per house to vary with economic conditions, with reductions in the occupancy ratio going hand-in-hand with faster economic growth.

The relative constancy of the year 2003 composition of the housing stock across simulations reflects the assumption that increasing real energy costs and rising construction costs will dominate other factors in the determination of future housing trends. One should impute no great meaning to the differences in year 2003 housing stock composition shown in the above table. What has meaning is the average year 2003 composition which is: single attached (17.8%), single detached (40.9%), apartments & duplexes (15.7%), and "other" (25.6%). In other words, the projection here is for a continuation

of recent trends toward smaller units and away from the single detached home. Table 7 gives the implications of a twenty-year continuation of these trends for the Yukon.

POPULATION, ROOM FOR FURTHER RESEARCH

Net migration to the Yukon, defined to equal the number of in-migrants less the number of out-migrants, is likely to be negative unless employment growth is strong enough to provide jobs for the natural increase in the labor force. The natural increase in the Yukon labor force is defined here to equal the net flow of persons between the Yukon labor force and the group of persons who were residents the year before but not in the labor force. We say "is likely to be negative" because (a) out-migrants can include persons not previously in the labor force, and (b) new entrants to the labor force can choose to remain Yukon residents even if they ultimately fail to find employment and ultimately exit the labor force. As a rule of thumb, however, it is fair to say that employment growth must at least equal the natural increase in the labor force if net migration is to be positive.

Except in the HIGH GROWTH case, net migration is projected to be negative virtually every year in all simulations. Overall population growth nevertheless occurs in the BASE CASE and LOW BUT POSITIVE simulations because the natural increase in the population exceeds the level of (negative) net migration. Only in the NEGATIVE GROWTH simulation is net migration sufficiently negative to cause overall population decline.

Text Table 8 compares the simulations on the basis of projected year 2003 population characteristics.

TABLE 8

POPULATION CHARACTERISTICS
1982 AND 2003 BY SIMULATION

		2003			
	1982	HIGH GROWTH	BASE CASE	LOW BUT POSITIVE	NEGATIVE GROWTH
Population	24,811	61,092	30,269	28,273	22,125
Native	4,149	5,584	5,584	5,584	5,584
Non-Native	20,662	55,508	24,685	22,689	16,541
Age 0 to 19	9,205	28,822	14,331	13,377	10,526
Age 20 to 65	14,824	30,126	14,638	13,655	10,433
Age 65 & Over	782	2,144	1,300	1,241	1,166
Labour Force	12,818	36,922	18,320	15,720	10,354

One should immediately notice that in three of the four simulations the year 2003 population age 20 to 65 is less than the labour force. This is, of course, an obvious inconsistency and very much in contrast with 1982 where the population ages 20 to 65 was 15.6 percent larger than the labour force. Clearly, the age distribution shown in Table 8 and in Tables 9NAT,...9HIGH (below), implies that an unusual percentage of the 2003 labour force would need to be drawn either from persons under age 20 or from those over age 65.

The age distributions shown in these tables were produced by a standard cohort-survival model using birth rates and death rates drawn from Vital Statistics [28B], and a distribution of in-migration by age group drawn from statistics of Canada [28A], (data on

inter-provincial in-migration to the Yukon by age group, 1979 to 1980.[1] The specific net migration percentages used were:[1/]

AGE	NON-NATIVE	NATIVE
0 to 4	9.6	ZERO
5 to 9	9.6	ZERO
10 to 14	8.1	ZERO
15 to 19	10.5	ZERO
20 to 24	15.4	ZERO
25 to 34	26.1	ZERO
35 to 44	11.2	ZERO
45 to 54	5.8	ZERO
55 to 64	1.9	ZERO
65 & over	1.8	ZERO
	100.0	ZERO

Non-Native male and female age groups were each assumed to have one-half the migration percentage for the respective age group. Net migration was assumed uniformly zero for Yukon Native peoples.

The age distributions shown in Table 8 suggest the need for one of two corrections to the population projections given here. The two possible corrections are: (1) raise overall net migration, and therefore population in each simulation so that the age 20 to 65 population, at projected percentages of total population, becomes "reasonably" large relative to the projected labour force; or (2) alter the distribution of net migration by age so as to increase

1/Percentage of total net migration by age group.

appropriately the percentage and number of persons in the age 20 to 65 age group.[1/]

The point of all this is that use of recent birth rates, death rates, and migration propensities implies a temporal change in the age distribution of the population which is inconsistent with projected total population and labour force requirements. Without further study, we are not prepared to say whether the appropriate "fix" to the simulations involves the use of different parameters or simply more in-migration or some combination of the two. Barring further research we point to the problem but do not solve it.

1/We should point out that in these simulations net migration was defined in each case by NEWYEM, the resulting annual level of net migration imposed on the cohort model, and the cohort model then solved for an age distribution (percentage distribution). Population totals from NEWYEM were then distributed according to these percentage distributions. Alternatively, the two models could have been combined. This was not done to save computer time in solving.

TABLE 9NAT
YUKON NATIVE POPULATION
BY AGE AND SEX
BASE CASE SIMULATION

	'82	'83	'84	'85	'86	'87	'88	'93	'98	2003
POPULATION	24511	24805	25076	25598	26193	26583	26832	27854	28772	30269
NATIVE	4149	4250	4346	4437	4523	4603	4678	4989	5265	5584
NON NATIVE	20662	20555	20730	21161	21670	21980	22154	22865	23507	24685
MALE	2286	2319	2350	2380	2409	2436	2461	2563	2659	2784
0 TO 4	150	216	264	299	324	339	349	349	345	368
5 TO 9	84	97	120	147	177	205	230	305	323	335
10 TO 14	112	105	103	106	113	125	140	224	279	304
15 TO 19	139	133	126	121	117	115	116	156	217	260
20 TO 24	294	260	232	209	190	173	160	136	165	209
25 TO 34	485	490	488	480	469	455	440	360	318	325
35 TO 44	368	375	382	388	393	395	397	381	345	318
45 TO 54	217	227	237	246	254	262	269	292	294	282
55 TO 64	162	164	167	170	174	178	183	206	223	230
65 & OVER	275	251	231	214	200	188	178	153	149	152
FEMALE	1863	1931	1996	2057	2114	2167	2217	2426	2606	2800
0 TO 4	144	211	260	295	320	336	345	345	341	364
5 TO 9	87	98	119	146	175	202	227	301	319	331
10 TO 14	86	86	87	93	103	117	133	221	277	302
15 TO 19	131	121	114	108	104	104	105	152	216	263
20 TO 24	268	240	216	194	177	162	150	131	165	214
25 TO 34	515	516	511	502	490	475	458	378	337	349
35 TO 44	267	290	311	330	345	357	367	381	362	344
45 TO 54	147	158	169	181	193	206	218	271	298	304
55 TO 64	102	103	106	109	113	117	123	155	187	209
65 & OVER	115	108	103	98	95	92	90	92	105	120

TABLE 9BC
YUKON NON-NATIVE POPULATION
BY AGE AND SEX
BASE CASE SIMULATION

	'82	'83	'84	'85	'86	'87	'88	'93	'98	2003
POPULATION	24811	24805	25076	25598	26193	26583	26832	27854	28772	30269
NATIVE	4149	4250	4346	4437	4523	4603	4678	4989	5265	5584
- NON NATIVE	20662	20555	20730	21161	21670	21980	22154	22865	23507	24685
MALE	10707	10617	10674	10866	11100	11227	11284	11504	11681	12147
0 TO 4	1289	1403	1494	1575	1641	1677	1690	1660	1636	1724
5 TO 9	976	996	1049	1123	1202	1269	1324	1477	1509	1555
10 TO 14	954	926	915	929	959	991	1025	1214	1336	1406
15 TO 19	1049	987	948	930	922	914	906	977	1109	1226
20 TO 24	900	883	874	852	890	879	850	819	881	1008
25 TO 34	2290	2137	2034	1980	1948	1889	1824	1551	1410	1459
35 TO 44	1528	1536	1551	1570	1588	1592	1583	1483	1354	1285
45 TO 54	975	977	993	1017	1045	1065	1081	1124	1111	1074
55 TO 64	563	576	594	616	638	659	679	771	834	861
65 & OVER	173	196	221	245	270	292	311	426	502	551
FEMALE	9955	9938	10056	10294	10571	10753	10870	11361	11826	12538
0 TO 4	1234	1358	1457	1541	1609	1668	1666	1642	1622	1709
5 TO 9	912	936	994	1071	1154	1224	1283	1451	1491	1539
10 TO 14	914	878	868	883	913	947	984	1190	1325	1403
15 TO 19	935	895	870	862	868	863	852	958	1112	1243
20 TO 24	988	935	904	893	890	873	852	818	899	1043
25 TO 34	2258	2146	2072	2033	2007	1962	1904	1657	1538	1609
35 TO 44	1335	1374	1420	1466	1511	1539	1554	1547	1478	1448
45 TO 54	722	750	790	836	885	928	965	1118	1195	1225
55 TO 64	440	442	452	468	488	509	530	651	763	843
65 & OVER	218	223	229	239	250	259	269	329	404	477

TABLE 9HIG4
YUKON NON-NATIVE POPULATION
BY AGE AND SEX
HIGH GROWTH SIMULATION

	'82	'83	'84	'85	'86	'87	'88	'93	'98	2003
POPULATION	24811	24939	25321	25962	26709	27293	34285	41693	48936	61092
NATIVE	4149	4250	4346	4437	4523	4603	4678	4989	5265	5584
NON NATIVE	20662	20689	20975	21525	22186	22690	29607	36704	43671	55508
MALE	10707	10686	10801	11057	11368	11596	15118	18590	21910	27696
0 TO 4	1289	1412	1513	1603	1691	1732	2255	2778	3170	4017
5 TO 9	976	1002	1061	1142	1229	1307	1740	2343	2814	3506
10 TO 14	963	932	926	944	980	1020	1353	1862	2392	3055
15 TO 19	1049	994	960	947	947	946	1238	1535	1989	2657
20 TO 24	900	890	890	905	922	924	1246	1430	1722	2354
25 TO 34	2291	2152	2063	2023	2006	1975	2567	2867	3090	3913
35 TO 44	1528	1546	1566	1593	1621	1636	2078	2427	2676	3188
45 TO 54	974	983	1002	1030	1062	1089	1390	1674	1958	2352
55 TO 64	564	579	599	621	645	669	848	1064	1318	1638
65 & OVER	172	197	223	249	275	298	402	609	781	1013
FEMALE	9955	10003	10173	10469	10818	11094	14489	18114	21761	27812
0 TO 4	1234	1367	1474	1568	1648	1703	2215	2741	3130	3965
5 TO 9	912	942	1005	1088	1178	1259	1680	2288	2762	3442
10 TO 14	914	854	878	896	933	974	1293	1805	2348	3009
15 TO 19	935	900	882	879	887	892	1171	1486	1960	2640
20 TO 24	988	943	918	914	919	914	1216	1396	1707	2355
25 TO 34	2259	2161	2099	2073	2065	2040	2631	2930	3191	4048
35 TO 44	1335	1383	1433	1488	1540	1580	2027	2458	2787	3364
45 TO 54	722	755	797	847	900	949	1244	1647	2045	2548
55 TO 64	440	444	456	472	494	517	666	906	1205	1582
65 & OVER	218	224	231	242	254	265	348	459	623	959

TABLE 9LBP
YUKON NON-NATIVE POPULATION
BY AGE AND SEX
SLOWER GROWTH SIMULATION

	'82	'83	'84	'85	'86	'87	'88	'93	'98	2003
POPULATION	24811	24374	24540	24694	24856	25022	25189	26094	27117	28273
NATIVE	4149	4250	4346	4437	4523	4603	4678	4989	5265	5584
NON NATIVE	20662	20124	20194	20257	20333	20419	20511	21105	21852	22689
MALE	10707	10393	10395	10396	10405	10418	10435	10605	10848	11146
0 TO 4	1289	1373	1454	1506	1537	1552	1557	1520	1516	1582
5 TO 9	976	975	1023	1077	1133	1186	1231	1361	1396	1429
10 TO 14	963	909	893	892	904	926	956	981	1023	1063
15 TO 19	1049	965	922	886	860	843	836	904	1034	1128
20 TO 24	900	856	842	824	804	785	768	745	821	922
25 TO 34	2291	2086	1972	1872	1785	1707	1637	1388	1292	1317
35 TO 44	1528	1509	1516	1513	1505	1492	1474	1360	1244	1166
45 TO 54	974	961	973	987	1000	1013	1024	1053	1035	986
55 TO 64	564	559	585	602	619	637	655	736	791	806
65 & OVER	172	192	216	237	258	278	297	409	481	520
FEMALE	9956	9731	9797	9861	9928	10002	10076	10500	11003	11542
0 TO 4	1234	1329	1418	1475	1509	1528	1535	1504	1501	1568
5 TO 9	912	917	969	1029	1089	1145	1195	1338	1380	1414
10 TO 14	914	861	848	848	863	888	920	1106	1231	1292
15 TO 19	935	875	847	823	807	798	798	990	1037	1145
20 TO 24	988	911	874	840	811	787	766	748	840	958
25 TO 34	2258	2099	2013	1933	1859	1792	1730	1501	1420	1465
35 TO 44	1334	1350	1388	1415	1434	1447	1453	1429	1369	1327
45 TO 54	722	736	773	809	845	881	914	1049	1118	1134
55 TO 64	440	436	445	457	472	489	509	620	722	790
65 & OVER	218	218	224	231	239	247	256	314	385	449

TABLE 9NEG
YUKON NON-NATIVE POPULATION
BY AGE AND SEX
NEGATIVE GROWTH SIMULATION

	'82	'83	'84	'85	'86	'87	'88	'93	'98	2003
POPULATION	24811	23076	22989	22920	22851	22806	22751	22504	22297	22125
NATIVE	4149	4250	4346	4437	4523	4603	4678	4989	5265	5584
NON NATIVE	20662	18826	18643	18483	18338	18203	18073	17515	17032	16541
MALE	10707	9719	9591	9477	9371	9272	9174	8752	8362	7971
0 TO 4	1289	1282	1340	1369	1379	1374	1359	1227	1125	1091
5 TO 9	976	913	946	986	1027	1063	1093	1141	1091	1033
10 TO 14	964	851	827	818	821	833	852	962	1007	987
15 TO 19	1049	902	848	804	771	746	731	754	831	865
20 TO 24	900	786	753	721	689	660	632	564	592	641
25 TO 34	2290	1939	1796	1670	1558	1457	1363	1000	791	702
35 TO 44	1528	1419	1412	1397	1374	1345	1313	1113	903	721
45 TO 54	975	907	913	921	929	935	939	927	857	743
55 TO 64	564	540	555	570	586	602	617	685	722	711
65 & OVER	173	179	200	220	239	258	276	379	445	476
FEMALE	9955	9107	9052	9006	8967	8931	8899	8762	8670	8570
0 TO 4	1234	1243	1308	1343	1357	1355	1343	1217	1119	1087
5 TO 9	912	859	897	943	988	1029	1064	1127	1086	1033
10 TO 14	914	808	787	780	785	801	824	952	1011	1000
15 TO 19	935	817	780	748	725	709	701	751	849	900
20 TO 24	988	941	788	744	705	671	643	581	627	698
25 TO 34	2258	1957	1845	1742	1647	1557	1474	1141	955	895
35 TO 44	1335	1270	1294	1307	1312	1311	1303	1201	1055	921
45 TO 54	722	694	722	752	781	809	836	930	952	911
55 TO 64	440	414	421	431	444	460	476	573	659	706
65 & OVER	218	206	210	216	221	228	236	289	356	418

Should, the proper correction to the simulations be to simply raise net migration, leaving the percentage distribution by age constant, the year 2003 total population for each of the four simulations would become:

HIGH GROWTH.....88,945
BASE CASE.....45,342
LOW BUT POSITIVE.....38,357
NEGATIVE GROWTH.....25,564

In our opinion these are extreme outside estimates. Tables 9NAT, 9BC, 9LBP, 9HI, and 6NEG present the detailed age-sex-race projections made for this report.

POLICY MULTIPLIERS

One purpose of this study is the assessment of prospects for job creation associated with alternative policy actions. We have used the NEWYEM econometric model for this purpose.

Four special simulations of NEWYEM were performed in addition to those discussed in the preceeding section. In each case the differences between the special simulation and the BASE CASE simulation were noted for four key variables projected by the model: population, disposable personal income, total wage/salary employment, and the number of self-employed persons. These differences when related to the defining change for each simulation give the 1-year, 2-year, 5-year, and 10-year policy multipliers of interest

here. The departures from BASE CASE assumptions which (together with the BASE CASE assumptions) define the four special simulations are as follows.

Special Simulation 1 - Mining employment is increased by 100 jobs beginning 1985.

Special Simulation 2 - The number of tourists is increased by 200,000 annually, beginning 1985.

Special Simulation 3 - The real annual rate of growth of federal spending is raised by two-tenths of one percent beginning in 1985.

Special Simulation 4 - An exogenous increase of $100,000 annually is added to disposable personal income.

The differences from BASE CASE levels generated by each of these four special simulations are shown in Table 10 for population, disposable personal income, and total employment. Because time lags between stimulus and response are variable and may be such that the responses to small stimuli are delayed relative to those of large stimuli, the 1-year and 2-year responses shown in Table 10 may overstate what, in truth, should reasonably be expected.[1/] For this reason the 5-year and 10-year responses may come closer to describing the impacts that actually would occur should the policy changes defining the special simulations actually be implemented, than do the 1-year and 2-year responses.

1/Refinements of the lag structure of NEWYEM were limited by the severe data constraints. See [23A].

TABLE 10

RESULTS OF SPECIAL SIMULATIONS
(DIFFERENCE FROM BASE CASE)

	AFTER 1-YEAR	AFTER 2-YEARS	AFTER 5-YEARS	AFTER 10-YEARS
POPULATION (NOS.)				
SS1	127	138	161	200
SS2	370	403	467	581
SS3	3	5	9	18
SS4	0	1	1	1
DISPOSABLE INCOME (000's)[1/]				
SS1	8,028	9,089	11,147	15,371
SS2	17,296	20,215	25,033	35,106
SS3	186	274	595	1,246
SS4	132	135	136	139
TOTAL EMPLOYMENT[2/] (NOS.)				
SS1	229	240	248	262
SS2	800	833	861	907
SS3	7	10	16	29
SS4	1	1	1	1

The results of these special simulations can be summarized by converting Table 10 into a table of multipliers wherein the departures from the BASE CASE levels are stated per unit of change in the reference variable. The reference variables are mining jobs (Special Simulation 1), number of tourists (Special Simulation 2), real federal spending (Special Simulation 3), and real exogenous disposable personal income (Special Simulation 4). Exogenous income can be thought of as grants or transfers to persons, or as constant dollar reductions in federal income taxes.

1/Nominal dollars. Deflator grows at 5 percent annually.
2/EQUALS WAGE & SALARY EMPLOYMENT + SELF-EMPLOYMENT.

The policy multipliers generated by NEWYEM (which are implicit in the Table 10 results) are presented in Table 11. Several points should be understood when reading this table.

First and most important, the model used to generate these multipliers specified federal spending to rise proportionate with population. This could prove to be a mis-specification of the federal response in any particular case. If, for example, federal policy was insensitive to population change over a modest range, the appropriate policy multipliers would be lower than those shown in Table 11.[1/] To get a feel for how much lower, Special Simulation 1 was re-run with federal spending independent of population change and growing at the annual average rate of growth posted in the BASE CASE simulation for the years 1983 to 2003. After ten years the 100 extra mining jobs produced only 201 total new jobs rather than the 262 new jobs shown in Table 10. <u>This suggests that if federal spending is insensitive to population growth (over the relevant range), then the policy multipliers shown in Table 11 may be as much as 25 percent too high!</u>

Second, the words "direct and induced" used in Table 11 mean the increase in question <u>plus</u> all changes generated by the successive respending of incomes and gross receipts. The 262 total jobs produced after ten years by the 100 extra mining jobs in Special Simulation 1 <u>include</u> the 100 extra mining jobs. The $139,000 in real extra disposable income generated per $100,000 in real extra ex-

1/For a discussion of the hazards model builders face if they incorrectly model the government response to population change see Reaume [23A].

TABLE 11

POLICY MULTIPLIERS

	AFTER 1-YEAR	AFTER 2-YEARS	AFTER 5-YEARS	AFTER 10-YEARS
DIRECT & INDUCED INCREASE PER EXTRA MINING JOB				
Total Employment	2.29	2.40	2.48	2.62
Disposable Income	63,412	67,626	69,495	71,294
Population	1.27	1.38	1.61	2.00
DIRECT & INDUCED INCREASE PER 1000 EXTRA TOURISTS				
Total Employment	4.00	4.16	4.30	4.54
Disposable Income	68,310	75,205	78,033	81,415
Population	1.85	2.02	2.34	2.90
DIRECT & INDUCED INCREASE PER $100,000 FEDERAL SPENDING (1983 $)				
Total Employment	4.07	3.97	3.40	3.74
Disposable Income	89,423	85,093	82,869	78,316
Population	1.74	1.98	1.91	2.32
DIRECT & INDUCED INCREASE PER $100,000 EXTRA EXOGENOUS DISPOSABLE INCOME (1983 $)				
Total Employment	1.3	2.22	2.34	2.70
Disposable Income	132,000	135,000	136,000	139,000
Population	0.93	1.28	1.52	2.05

NOTES: UNITS: TOTAL EMPLOYMENT - JOBS
DISPOSABLE INCOME - 1983 DOLLARS
POPULATION - PERSONS

ogenous disposable income includes the original $100,000, and so forth. Thus, for example, in examining Table 11, it is not correct to conclude that a $100,000 reduction in taxes (Simulation 4) has a greater impact than a $100,000 increase in federal spending, only that it has a greater income creating effect, and this largely because the initial $100,000 increase happens to itself count as income.

Third, one should not become too doctrinaire about the size of these policy multipliers. In practice, multipliers are likely to vary with the size of the stimulus. Those shown in Table 11 are drawn from an econometric model, itself only an approximation to reality.

ENERGY DEMAND

In a recent publication entitled Northern Energy, Hodge and Ehrlich present base year (1978) estimates of energy consumption in the Yukon on a fuel and sector specific basis, and also projections of energy consumption on this basis for the years 2000 and 2025.[1/] In making their projections they depended on an early set of economic simulations made with the aid of the predecessor of the current Yukon econometric model [27A].

The Hodge-Ehrlich estimates of 1978 Yukon energy consumption remain the only authoritative point-in-time estimates available. Accepting their 1978 estimates as a starting point, we have re-projected Yukon energy consumption through the year 2003, once for each of

1/ Hodge and Ehrlich, [12].

the four economic simulations discussed above (BASE CASE, LOW BUT POSITIVE, NEGATIVE, HIGH). In making these projections the new Yukon Energy Demand model [23B] was used for purposes of estimating future residential and commercial energy demand. Proforma projections of industrial and transportation sector demand, (dependent respectively on (a) the sum of mining and construction employment, and (b) population) supplement the energy model forecasts of commercial and residential energy demand. Although the Yukon Energy Demand model contains nascent transportation and industrial sectors, financial constraints and data limitations faced by the developers made it impossible to specify more than a framework for analysis in these two sectors.

Residential

Hodge and Ehrlich estimated that the Yukon residential sector consumed 1,260 terajoules of energy in 1978. Our 1982 estimate of 1,256 terajoules happens to nearly coincide with the earlier figure only because the estimated demand increasing effects of population growth and real income growth have been offset by price induced conservation efforts. In making the 1982 residential consumption estimates it was assumed that the own price elasticity of electric-specific consumption was -1.09, that the income elasticity of electric-specific consumption was 0.8, and that the income elasticity of heating-cooling energy consumption was 0.08. Income in this context was defined to be real disposable personal income net of the cost of household energy. Rising real energy prices were assumed to reduce consumption by reducing the level

of real income available for consumption of non-energy goods and services, and for savings.[1/] Between 1978 and 1982, estimated real per capita disposable income net of energy costs fell from $9,474 to $9,141. Yukon population rose from 23,306 to 24,811 over this period and the estimated number of households from 6,950 to 7,742. Persons per house declined from 3.4 in 1978 to an estimated 3.3 in 1982. During the 1978 to 1982 period, economic conditions initially improved and then worsened. This last point can be seen from the estimates of real per capita disposable income net of energy costs which for the years 1978 through 1982 are, respectively: $9,474, $10,511, $10,218, $10,598, and $9,141.

Tables 12BC, 12LBP, 12NEG, and 12HI record the projections of future residential energy consumption made by combining our earlier economic forecasts with the elasticity assumptions stated in the previous paragraph, and the further assumption that real energy prices rise at a constant 2.0 percent annual rate. It is worth noting that under these economic assumptions residential energy consumption changes less than proportionately with the number of households in the NEGATIVE and LOW BUT POSITIVE simulations but more than proportionately with the number of households in the BASE CASE and HIGH GROWTH simulations.[2/]

1/See [23B] for details of the model's specification.

2/Differences in year 2003 consumption from the level representing household proportionate growth are:

NEGATIVE.....(-3.0%)
LOW BUT POSITIVE.....(-0.1%)
BASE CASE..... +0.6%
HIGH GROWTH..... +4.6%

TABLE 12BC
YUKON ENERGY DEMAND
BASE CASE SIMULATION
(DELIVERED TERAJOULES)

	'82	'83	'84	'85	'86	'87	'88	'93	'98	2003
RESIDENTIAL	1255.5	1252.4	1271.0	1343.5	1429.3	1471.3	1495.6	1522.2	1553.5	1671.6
HEAT/COOL	1130.3	1128.3	1143.4	1202.5	1274.9	1311.7	1324.8	1361.1	1395.1	1501.1
ELECTRIC	180.0	179.7	182.1	191.5	203.0	208.9	211.0	216.8	222.2	239.1
FUEL OIL	709.8	708.6	718.0	755.2	800.6	823.8	832.0	854.8	876.2	942.8
WOOD	240.5	240.0	243.3	255.8	271.3	279.0	281.8	289.5	296.8	319.3
ELEC. SPEC.	125.2	124.1	127.6	141.0	154.4	159.6	160.8	161.1	158.4	170.5
COMMERCIAL	1643.8	1665.4	1693.2	1768.4	1829.5	1856.5	1867.3	1895.7	1896.2	1964.3
HEAT/COOL	1278.6	1299.4	1326.3	1391.5	1444.0	1469.5	1482.3	1528.3	1550.6	1628.6
FUEL OIL	1278.6	1299.4	1326.3	1391.5	1444.0	1469.5	1482.3	1528.3	1550.6	1628.6
ELEC. SPEC.	365.2	366.0	366.9	376.9	385.5	387.0	385.0	367.4	345.6	335.7
SUB TOTAL	2899.4	2917.8	2964.2	3111.9	3258.8	3327.9	3352.9	3417.9	3449.7	3635.9

TABLE 12HI
YUKON ENERGY DEMAND
HIGH GROWTH SIMULATION
(DELIVERED TERAJOULES)

	'82	'83	'84	'85	'86	'87	'88	'93	'98	2003
RESIDENTIAL	1255.5	1246.4	1259.4	1305.0	1355.8	1394.6	1873.1	2525.4	2848.3	3537.1
HEAT/COOL	1130.3	1122.4	1131.6	1166.1	1206.7	1230.4	1636.3	2249.3	2533.5	3132.1
ELECTRIC	180.0	178.7	180.2	185.7	192.2	196.0	260.7	358.3	403.4	498.9
FUEL OIL	709.8	704.9	710.7	732.3	757.9	772.7	1027.7	1412.6	1591.1	1967.2
WOOD	240.5	238.7	240.7	248.0	256.7	261.7	347.9	478.4	538.9	666.0
ELEC. SPEC.	125.2	124.0	127.8	138.9	149.1	154.2	241.7	276.2	314.8	405.0
COMMERCIAL	1643.8	1536.4	1590.5	1690.9	1788.0	1859.5	2615.6	3114.9	3881.3	5244.4
HEAT/COOL	1278.6	1196.1	1241.7	1324.4	1403.6	1462.8	2072.1	2456.6	3096.7	4237.0
FUEL OIL	1278.6	1196.1	1241.7	1324.4	1403.6	1462.8	2072.1	2456.6	3096.7	4237.0
ELEC. SPEC.	365.2	340.3	348.8	366.4	384.4	396.7	543.5	658.3	784.6	1007.4
SUB TOTAL	2899.4	2782.8	2850.0	2995.8	3143.8	3244.1	4493.7	5640.4	6729.7	8781.4

TABLE 12LBP
YUKON ENERGY DEMAND
LOW BUT + GROWTH
(DELIVERED TERAJOULES)

	'82	'83	'84	'85	'86	'87	'88	'93	'98	2003
RESIDENTIAL	1255.5	1232.6	1233.7	1232.8	1234.9	1236.5	1238.7	1245.1	1311.9	1387.7
HEAT/COOL	1130.3	1113.1	1113.5	1112.4	1113.6	1114.9	1116.7	1122.0	1182.0	1250.3
ELECTRIC	180.0	177.2	177.3	177.1	177.4	177.6	177.9	178.7	188.3	199.2
FUEL OIL	709.8	699.0	699.3	698.7	699.4	700.1	701.2	704.6	742.4	785.3
WOOD	240.5	236.8	236.8	236.6	236.8	237.1	237.6	238.7	251.4	265.9
ELEC. SPEC.	125.2	119.6	120.2	120.3	121.3	121.7	122.0	123.1	129.9	137.4
COMMERCIAL	1643.8	1724.9	1734.1	1739.3	1744.6	1751.6	1758.5	1764.8	1825.6	1863.1
HEAT/COOL	1278.6	1346.4	1358.3	1366.9	1375.3	1385.5	1395.6	1422.6	1493.7	1545.7
FUEL OIL	1278.6	1346.4	1358.3	1366.9	1375.3	1385.5	1395.6	1422.6	1493.7	1545.7
ELEC. SPEC.	365.2	378.5	375.8	372.4	369.3	366.2	362.9	342.2	331.8	317.4
SUB TOTAL	2899.4	2957.5	2967.3	2972.1	2979.5	2988.1	2997.2	3009.8	3137.4	3250.8

TABLE 12NEG
YUKON ENERGY DEMAND
NEGATIVE GROWTH
(DELIVERED TERAJOULES)

	'82	'83	'84	'85	'86	'87	'88	'93	'98	2003
RESIDENTIAL	1255.5	1236.2	1221.5	1207.7	1196.3	1183.3	1170.5	1108.6	1050.5	995.4
HEAT/COOL	1130.3	1116.0	1104.0	1092.4	1082.0	1071.0	1060.1	1007.1	956.9	909.8
ELECTRIC	180.0	177.7	175.8	174.0	172.3	170.6	168.8	160.4	152.4	144.9
FUEL OIL	709.8	701.0	693.4	686.1	679.7	672.6	665.8	632.4	600.9	571.5
WOOD	240.5	237.3	234.8	232.3	230.1	227.8	225.6	214.3	203.5	193.4
ELEC. SPEC.	125.2	120.2	117.5	115.2	114.2	112.3	110.4	101.5	93.6	86.6
COMMERCIAL	1643.8	1614.8	1587.6	1565.9	1546.6	1528.1	1510.2	1436.3	1379.6	1338.0
HEAT/COOL	1278.6	1270.2	1257.4	1248.0	1240.2	1232.4	1224.7	1195.8	1175.4	1163.4
FUEL OIL	1278.6	1270.2	1257.4	1248.0	1240.2	1232.4	1224.7	1195.8	1175.4	1163.4
ELEC. SPEC	365.2	344.6	330.2	318.0	306.5	295.7	285.5	240.5	204.1	174.5
SUB T	2899.4	2850.9	2809.1	2773.6	2742.9	2711.3	2680.6	2544.8	2430.0	2334.4

Commercial (Includes Government)

Also shown in Tables 12BC, 12LBP, 12NEG, and 12HI are projections of commercial energy demand in the Yukon corresponding to each of the four primary economic simulations. Hodge and Ehrlich's [12] estimate of 1978 Yukon commercial energy consumption is 1,581 terajoules. The 1982 estimate of 1,644 terajoules is only 4.0 percent greater than Hodge and Ehrlich's 1978 estimate.

For purposes of these projections, heating/cooling energy consumption is assumed to grow proportionately with the estimated square footage of commercial floor space, while consumption of electricity for specific uses other than heating and cooling grows proportionately with employment, adjusted for an own price elasticity of -1.09.[1/] Although the Yukon Energy Demand model is equipped to handle non-zero price elasticities of heating/cooling demand, and technologically induced increases in electrification, no such responses were built into the commercial demand projections shown here. In effect, we have assumed that price induced reductions in consumption (conservation) will be just offset by the increasing electrification of the workspace, at least in terms of total terajoule demand.

1/Employment in services, communications & utilities, and government.

Industrial/Transportation

Table 13 presents pro-forma, "constant-per-employee," projections of industrial energy demand and constant per capita projections of the demand for liquid transportation fuels. Given a continuation of recent O.E.C.D. trends in energy conservation, or even somewhat below trend increases in energy use (per unit of output produced in industry or per transportation kilometer traversed), the projections in Table 13 could err on the high side by a non-negligible amount by the year 2003.[1/]

According to the International Energy Agency, O.E.C.D. Total Primary Energy requirements (TPE) grew in step with real O.E.C.D. gross domestic product between 1960 and 1973, but only one-tenth as fast between 1973 and 1981.[2/] Because the Table 13 projections assume that industrial energy demand in the Yukon will grow in step with employment, rather than with real gross domestic product, and because one might expect labor productivity to be such that real product grows faster than employment, the Table 13 projections implicitly allow for a continued decline in energy use per unit of real industrial product at roughly the rate of growth of labor productivity (in the positive growth scenarios).

1/The O.E.C.D. International Energy Agency pointed out in its 1982 report World Energy Outlook that while real GDP in the O.E.C.D. countries had grown 19 percent since 1973, energy consumption had grown only 4 percent, and oil use 3 percent. However, the report cautions as have others: "With oil prices falling, there is a danger that misleading market signals will cause both complacency among energy consumers and hesitation among investors, with the result that problems seen for the late 1980's and 1990's are not adequately dealt with in time." World Energy Outlook [19], p. 13.

2/ [19] p. 69.

TABLE 13

YUKON ENERGY DEMAND[1/]
INDUSTRIAL-TRANSPORTATION
(Delivered Terajoules)

	1982	1983	1984	1985	1986	1987	1988	1993	1998	2003
INDUSTRIAL										
Base Case	1226	1274	1363	1644	1985	2130	2125	1892	1514	1566
Low But +	1226	1131	1151	1158	1164	1173	1178	1205	1237	1268
Negative	1226	1119	1109	1102	1095	1090	1083	1051	1023	999
High	1226	1274	1375	1653	2004	2178	3286	3056	2824	3076
TRANSPORTATION										
Base Case	4153	4152	4197	4285	4384	4450	4491	4662	4816	5066
Low But +	4153	4080	4108	4133	4160	4188	4216	4368	4539	4732
Negative	4153	3863	3848	3836	3827	3817	3808	3767	3732	3703
High	4153	4174	4238	4346	4471	4568	5739	6979	8191	10226
SUBTOTAL										
Base Case	5379	5425	5560	5928	6370	6579	6616	6554	6330	6633
Low But +	5379	5211	5259	5291	5324	5361	5394	5573	5776	6000
Negative	5379	4981	4957	4939	4921	4907	4891	4181	4756	4703
High	5379	5449	5614	5999	6474	6746	9024	10035	11015	13302

1/ Constant per-employee projection for the industrial sector, constant per-capita projection for the transportation sector.

According to Hodge and Ehrlich, the Yukon industrial sector consumed 2,145 terajoules of energy in 1978, and the transportation sector 3,901 terajoules. Of the liquid transportation fuels consumed, 48.6 percent was burned in automobiles, 37.2 percent in motor trucks, and 12.7 percent in aircraft. The remaining 1.5 percent was used by boats, trains, and busses.[1/] The demographic assumptions upon which Hodge and Ehrlich based their year 2000 projections of transportation energy consumption, called for a year 2000 Yukon population of 41,600 persons in their "business as usual" case. As it happens, the year 1993 population projection in the present HIGH GROWTH simulation is 41,693. This suggests a comparison between 1993 HIGH GROWTH transportation demand from Table 13 and Hodge and Ehrlich's year 2000, business as usual, projection.

	HODGE & EHRLICH, 2000 Population - 41,600	HIGH GROWTH, 1993 Population - 41,693
TRANSPORTATION DEMAND	5,156 terajoules	6,979 terajoules

One can gather from this comparison, that alternative reasonable assumptions could lead to a downward revision of up to 40 percent in the Table 13 estimates for year 2003 transportation energy demand. Among the assumptions imposed by Hodge and Ehrlich but not imposed in preparing Table 13 were (1) in the year 2000 the average automobile travels 53 kilometers for every gallon of gasoline consumed (up from 15 in 1978), and (2) Yukoners own 2.3 vehicles per household in the year 2000, down from 2.6 in 1978.

1/See [12] Table YT-7.

The increase in vehicle fuel efficiency of 89 percent over the 1978 to 2000 period assumed by Hodge and Ehrlich is somewhat greater than the 35 percent increase in efficiency assumed by the International Energy Agency in its 1982 report.[1/] This difference dramatizes the uncertainty which attends even the formulation of critical assumptions. In point of fact, as any economist worth his assumptions will point out, future increases in fuel burning efficiency in automobiles, trucks, or anywhere else, are in large part price dependent. The implicit price assumption behind the Table 13 projections of transportation demand is that real energy prices rise 2.0 percent over the 1982 to 2003 period. Because this assumption is open to challenge, and because the scope of this study precludes an in-depth analysis of future energy saving technological innovations, the Table 13 projections are offered only as pro-forma, benchmark estimates, which in the case of transportation demand could well err on the high-side by an uncertain amount.

A Comment On Industrial Energy Demand

In a 1976 report published by Energy, Mines, and Resources Canada [8A], projections of energy demand for Canadian mineral industries were made on the assumption that energy use per net ton of production would remain constant. The authors, however, observe (p.10) that "improved technology and increased recycling, could reduce by 30 percent the forecast energy consumption for the year 2000."

1/World Energy Outlook, [19], p. 102.

Assuming that labor productivity grows by as little as 0.5 percent per year, the 2003 projections of industrial demand shown in Tables 13 and 14 are 10.5 percent lower than what they would have been had a constant energy per unit of output assumption been imposed.[1/] Whether or not one believes this to be an adequate allowance for technological progress should turn on one's expectations for future change in relative labor and energy prices. Should labor costs rise substantially faster than energy costs, substitution of energy for labor via the use of new processes and new equipment could produce substantial increases in energy used per worker, while at the same time reducing labor requirements per tonne of output from the levels projected in this study. The. U.S. Bureau of Mines in its 1980 Mineral Facts and Problems [18B, p. 1042] had this to say about technological change in zinc processing. "With the rising costs of mining and the shortage of mine and mill labor, more emphasis will be placed on automation of every possible operation in mining." With respect to silver extraction, the same report [p. 834] says, "Newer techniques that might be applicable to leaching and chemical processing of silver ores are under investigation in the laboratory, and if found appropriate for field use, a new method of production could result."

We do not believe that one can casually assume that changes over the next twenty years in labor costs and energy costs will necessarily be such as to lead to major reductions in the energy in-

1/A one percent per year assumed growth in labor productivity carries an implicit 22 percent reduction in energy consumption per unit of output after 20 years.

tensity of industrial production processes. For this reason the industrial energy demand forecasts presented here have been made in a straight-forward manner.

Electricity Demand

On the assumption that electricity will account for a constant 26.5 percent of industrial energy demand through the year 2003 (Hodge and Ehrlich's estimate for 1978), the industrial electricity demand projections in Table 14 have been obtained from the corresponding Table 13 estimates. (Again, one should realize that this is a pro-forma statement whose ultimate accuracy depends upon a number of factors.) Table 14 also includes residential and commercial sector demand estimates translated into gigawatts from Tables 12BC.....

According to information provided by Yukon Electrical, Yukon power companies either generated or purchased from the Northern Canada Power Commission a total of 199.4 gigawatt hours of power in 1982. The difference between this figure and the 1982, Table 14 estimate of 276.6 gigawatt hours used in total, is accounted for by power consumed at mine sites and by statistical error in the Table 14 estimates. When in full operation, the Cyprus Anvil mine at Faro and the Faro townsite consume an estimated 170 gigawatt hours, while the United Keno Hill operation consumes approximately 38 gigawatt hours at the townsite and the mine combined.[1/] The Northern

1/According to information provided in [30A].

Canada Power Commission supplies hydroelectric power to both the Faro and the Elsa operations.

The BASE CASE and HIGH GROWTH projections of industrial electricity demand could be conservative, if new mining operations consume significantly more electricity than the constant per-employee industrial estimates given in Table 14. This problem may not be as important in the two remaining projections because major mining operations do not appear in either the LOW BUT + or the NEGATIVE GROWTH scenarios. Bearing this point in mind, the following tentative conclusions can be offered.

- The Yukon demand for electrical energy is unlikely to exceed 1000 gigawatt hours annually, even by the year 2003.
- Daily peak electrical demand is likely to fluctuate widely during the year, declining seasonally when milling operations are curtailed (BASE CASE, and HIGH GROWTH).
- Year-to-year and month-to-month changes in capacity generating requirements are heavily dependent upon swings in industrial (minesite) demand. BASE CASE projections dramatize this point. By the year 2003, estimated industrial electricity demand is only 74 percent of the peak reached in 1987.
- If one allows for modest technology-induced increases in the amount of residential and commercial electricity used per household or per employee (which Table 11 does not do),

TABLE 14

YUKON DEMAND FOR ELECTRICITY
(Gigawatt Hours)1/

	1982	1983	1984	1985	1986	1987	1988	1993	1998	2003
BASE CASE	276.6	280.1	288.6	318.5	352.7	367.1	366.9	346.5	313.3	322.5
Residential	84.8	84.5	86.2	92.6	99.2	102.6	103.4	105.1	105.6	113.7
Commercial	101.5	101.7	102.0	104.8	107.3	107.6	107.0	102.0	96.2	93.4
Industrial	90.3	93.9	100.4	121.1	146.2	156.9	156.5	139.4	111.5	115.4
LOW BUT +	276.6	271.0	271.9	271.3	271.2	271.5	271.1	267.9	271.8	274.9
Residential	84.8	82.6	82.6	82.6	82.8	83.4	83.4	84.0	88.4	93.4
Commercial	101.5	105.1	104.5	103.4	102.6	101.7	100.9	95.1	92.3	88.1
Industrial	90.3	83.3	84.8	85.3	85.8	86.4	86.8	88.8	91.1	93.4
NEGATIVE	276.6	261.1	255.1	249.9	245.3	241.2	236.9	216.9	200.5	186.5
Residential	84.8	82.8	81.7	80.3	79.5	78.7	77.6	72.8	68.4	64.5
Commercial	101.5	95.9	91.7	88.4	85.1	82.2	79.5	66.7	56.7	48.4
Industrial	90.3	82.4	81.7	81.2	80.7	80.3	79.8	77.4	75.4	73.6
HIGH GROWTH	276.6	272.6	283.9	313.9	349.2	368.2	533.1	584.3	625.8	757.8
Residential	84.8	84.2	85.6	90.4	94.8	97.3	139.8	176.3	199.6	251.3
Commercial	101.5	94.5	97.0	101.7	106.8	110.4	151.2	182.9	218.2	279.9
Industrial	90.3	93.9	101.3	121.8	147.6	160.5	242.1	225.1	208.0	226.6

1/ 1 terajoule = 278 MWH
1000 megawatt hours = 1 gigawatt hour

there is little likelihood that future electricity demand will fall dramatically from 1982 levels, even if something like the NEGATIVE GROWTH scenario comes to pass.

- PUBLIC SECTOR CAPITAL REQUIREMENTS -

For the twelve year period beginning with 1967 and ending with 1978, estimates of gross fixed government capital formation in Yukon can be found in the Yukon Economic Accounts [9A]. This was a period of moderate growth in Yukon. Population rose from 15,000 persons to 23,300 persons on the strength of increased mining activity, rising government spending, and mounting tourist expenditure. With population growing some 55 percent over the period, government was forced to deepen Yukon's infrastructure by expanding and improving the road system, constructing schools, and, in general, assurring that public services and public capital improvements kept up with the growing number of Yukon residents. As recorded in the Economic Accounts, public sector capital formation stated in constant 1983 dollars, totaled $784.3 million for the twelve year period, an average of $65.4 million per year. To put these figures in better perspective, had national public sector investment maintained the same per capita rate as in Yukon, in total, it would have averaged approximately $70 billion per year (1983 dollars) or approximately six times the actual annual national gross capital formation by government over the same period.[1/]

One should not be surprised that per capita gross fixed capital expenditure in Yukon greatly exceeded the national average over the historical period. Developing economies such as Yukon simply do

1/Statistics Canada. Military expenditure is excluded. In all cases "government" means combined federal, territorial, and local, as does "public sector."

not have the infrastructure in place that developed economies take for granted. During the 1967 to 1978 time period for which data are available, the town of Faro, for example, grew essentially from nothing to a place where nearly 8 percent of Yukon's total population lived and worked. Because Yukon remains relatively undeveloped, and also because the historical annual average rate of population growth falls within the range bounded from above by the present HIGH GROWTH simulation, one should expect similar demands to be placed on Yukon's governments in the future, as were placed on them over the past fifteen years.[1/]

YUKON'S EXISTING PUBLIC CAPITAL

Although dollar measures of aggregate capital stocks are subject to well known index number problems, it does no harm to construct them, if one recognizes that they are only useful as approximate measures of size and not as indicators of productive capability. A common method of developing a capital stock measure recognizes that if investment data are available for a sufficiently long period of time, one can ignore initial conditions (the beginning capital stock) and worry solely about additions to the stock (net new capital formation). In effect, if one has a sufficiently long time series on net new capital formation, one ignores the beginning capital stock on the grounds that it is nearly or completely depreciated by the end of the time period.

1/Between 1967 and 1978, the period for which expenditure data are available, Yukon's population grew at a compound annual average rate of 4.1 percent. When calculated over the longer 1967 to 1983 period, the figure declines to 3.2 percent. For the 1983-2003 period, population growth in the HIGH simulation averages 4.6 percent per year. (Table 6HI)

Applying this method to the historical data on net new government capital formation in Yukon (with our own estimates for 1979 to 1982), we conclude that Yukon's public capital on December 31, 1982 (stated in 1983 dollars) amounted to $1.012 billion.[1/]

FORECASTS 1983 TO 2003

In order to produce the four simulations prepared for this study it was necessary to assume a dollar amount of gross fixed capital formation for each year 1983 to 2003. In so doing, government capital formation was treated as a policy lever, rather than as a category of spending to be determined by population growth, public preference and (of course) a degree of historical accident. For purposes of reference, one may recall that the growth rates of public real inflation adjusted (gross) capital formation assumed for the four simulations were:

BASE CASE.....2.0 percent per year
LOW BUT POSITIVE.....2.0 percent per year
HIGH GROWTH.....4.0 percent per year
NEGATIVE GROWTH.....(-2.0) percent per year

In this section the following question is answered: Assumming that other elements of government spending can be altered so as to achieve the same four population forecasts given above (BASE CASE,.....),

1/Details of the calculation are available on request. In brief, a 1967 capital stock of $529 million (1983 dollars) was estimated, and a 5 percent rate of depreciation assummed. The estimates for 1979-1982 were made by setting net government capital formation in each year equal to $70,930 times the year-to-year change in Yukon population, where $70,930 is the 1967 to 1978 mean of the annual ratios of net government capital formation (1983 dollars) to the change in population, excluding 1968 and 1974, two years where estimated population change was zero.

what does a repetition of the 1967 to 1978 historical response of government capital formation to population growth portend for the future? Stated differently, what are the future government capital requirements in Yukon that follow from each of the four population forecasts under 1967 to 1978 behavioral assumptions?

At this point the careful reader might respond by pointing out that population growth is not the sole determinant of government capital requirements. It also matters just how a given growth path of population is achieved. Some industries place greater burdens on public capital budgets than do others. Furthermore, the public budget is not determined solely by demand pressures. Financial constraints and political judgement play a major role.

One can only agree with such comments. But surely, however, when policymakers ask what public sector capital requirements are implied by a given twenty-year simulation of economic activity, one must respond with appropriate generality. If, instead, one were to base one's response on too specific a set of assumptions (e.g. very precise statements as to the location and character of each and every economic activity), policymakers could justly complain that the very specificity of the assumptions makes it difficult to judge the sensitivity of the answer. Does anyone doubt that there are at least a dozen different ways to build a schoolhouse or at least a hundred reasonable sets of assumptions that could produce one single growth path for population, income and total employment, each path with a very distinct pattern of public sector capital requirements?

TABLE 15

PUBLIC SECTOR CAPITAL REQUIREMENTS
(Millions of 1983 Dollars)

BASIS FOR PROJECTION	AVERAGE PER YEAR 1983-2003	TOTAL 1983-2003	PRESENT VALUE OF TOTAL @ 4% DISC.
POPULATION DEPENDENT			
HIGH GROWTH	225.9	4,743.1	3,066.2
BASE CASE	78.3	1,644.9	1,126.1
LOW BUT +	66.6	1,397.9	938.7
NEGATIVE GROWTH	33.9	712.2	461.0
ASSUMED FOR SIMULATION			
HIGH GROWTH	113.6	2,384.8	1,566.6
BASE CASE	89.8	1,886.4	1,274.0
LOW BUT +	89.8	1,886.4	1,274.0
NEGATIVE GROWTH	57.9	1,215.2	868.6

NOTE: Actual gross government capital formation was $58.7 million in 1978, equivalent to $104 million in 1983 dollars. This is the last year for which actual data were available at the time this report was prepared. In 1976 and 1977, gross government capital formation (1983 $) was $65.1 million and $74.0 million, respectively.

SOURCE: Yukon Economic Accounts [9A], adjusted to 1983 dollars by the Yukon CPI defined in [23B].

Table 15 presents estimates of the public sector capital requirements implied by population growth for each of the four main simulations prepared for this study. In addition, the levels of capital spending assummed in preparing each simulation are given. The remainder of this discussion focuses on the "population dependent" projections.[1/]

Table 15 does not give the actual time paths of gross government capital formation, for the simple reason that the precise timing of capital expenditure is somewhat arbitrary. Far more relevant is the annual average expenditure required to "keep pace" with population growth, and the total twenty-year financial requirement. Although the present value of future government capital requirements is dependent on the manner in which spending is distributed over time, the numbers are nonetheless presented in order to give policy makers a rough estimate of the size of the fund that would need to be established today in order to finance future gross government capital formation. Many people prefer to think in these terms. Because the numbers discounted in calculating the present values are all in constant (inflation free) dollars, a real dis-

1/Annual gross capital formation was first estimated in constant 1976 dollars and then adjusted to 1983 dollars. The equations used were

IG76YK = 32.99*ΔNYK+.05*KG76YK(-1)
KG76YK = KG76YK(-1)+IG76YK-.05*KG76YK(-1)
IG83YK = 2.15*IG76YK

where IG76YK and IG83YK are gross government capital formation in 1976 and 1983 dollars, respectively; ΔNYK is the year-to-year change in Yukon population; and KG76YK is public stock in 1976 dollars. The coefficient of ΔNYK is the mean of the annual ratios of net government capital formation to the change in population calculated over the 1967 to 1978 period (1976 $). The coefficients .05 and 2.15 are respectively: an assummed depreciation rate, and the ratio of the 1983 value of the Yukon CPI to the 1976 value. A 5 percent rate of depreciation was also used in calculating 1967 to 1978 net government capital formation.

count rate is used rather than a nominal rate. This accounts for the low value chosen (4 percent).

Total gross government capital requirements implied by BASE CASE population assumptions (stated in 1983 dollars) come to approximately $1.64 billion, an amount some 62 percent greater than the $1.01 billion public sector capital stock estimated above for December 31, 1982. Not all of this, however, represents a net addition to Yukon public sector capital, since some future expenditure must be devoted to financing replacement capital. Under an assumed 5 percent annual rate of depreciation, the stock of public sector capital grows only 38.3 percent between the end of 1982 and the end of year 2003, reaching a 1983 dollar level of $1.4 billion by that time.[1/] On average, $78.3 million in 1983 dollars gross government capital formation is required each year, of which 75 percent is replacement investment (repair, new facilities to replace old).

The extremes of what can reasonably be expected under the assumptions imposed are given by the "population dependent" HIGH GROWTH and NEGATIVE GROWTH projections in Table 15. In the NEGATIVE GROWTH scenario, required gross government capital formation in 1983 dollars amounts to $712.2 million in total, or an average of $33.9 million per year. Under the assumed 5 percent rate of

1/The rate of depreciation as used here represents physical obsolescence. Repair costs are included in replacement expenditure. In effect, the assumption is that in the absence of maintenance, public facilities would, on average, become totally useless in twenty years. Of course, long before that time, reasonable observers would call for their repair. (e.g. the Alcan Highway)

physical depreciation, Yukon's stock of public sector capital declines by 19 percent over the twenty year simulation period, reaching a level of $821.5 million by the end of year 2003. This, of course, should not be surprising.[1/] In the NEGATIVE GROWTH scenario the physical deterioration of existing public capital outstrips on balance the level of replacement investment. This does not mean that no new facilities are built, only that in value they are surpassed by depreciation losses elsewhere.

In the HIGH GROWTH simulation, net new capital formation by government proceeds rapidly in response to the demands of a growing Yukon population. Over the twenty year projection period, public sector gross capital formation averages $225.9 million per year, and totals $4.7 billion for the entire period. At the end of year 2003, the estimated value of the Yukon public sector capital stock equals $3.6 billion.

- GOVERNMENT REVENUE -

All four of the simulations prepared for this report embodied the assumption of balanced government budgets at the Territorial and Local levels. The ability to pre-program the size of the non-federal deficit (in these cases always zero) is a feature of the NEWYEM econometric model [23B]. No attempt was made, however, to

1/If Cyprus Anvil never re-opened and no other hard rock mines come on stream (as assumed in the NEGATIVE GROWTH scenario) would one not expect to see some net deterioration of roads and facilities in the cities which grew up on mining?

equate total federal spending in Yukon to revenue obtained from Yukon sources by the federal government.

Because the Territorial and Local government deficits are uniformly zero, total revenue for these governments is equal to total spending. These numbers are shown above in Tables 6BC, 6LBP, 6NEG, and 6HI, and reprinted below in Tables 16BC, 16LBP, 16NEG, and 16HI along with the principal "own source" components of non-federal revenue raised in Yukon. The equations with which these projections were made are included in NEWYEM and discussed in [23B].

Yukon local governments and Yukon Territorial government are heavily dependent upon federal transfers. Their two principal sources of revenue outside of federal transfers, namely indirect taxes and "other" current revenue,[1/] accounted for only 12.9 percent of total revenue at the local level, according to the estimates prepared for this report.[2/] In 1978, the most recent year for which comprehensive official data are available, the respective percentages were 12.8 percent (Territorial) and 37.3 percent (Local).[3/]

Only in the NEGATIVE GROWTH simulation does the share of total revenue obtained from own sources change noticeably from the 1982 pattern. In this simulation indirect taxes and other current

1/"Other" current revenue equals total current revenue less transfers from other governments, indirect taxes, and investment income.
2/At the time of writing, historical data consistently defined were available only through 1978.
3/Data for 1978 from [9A]. Note that in [9A] "other" current revenue is netted against expenditure. Here "other" is included in total revenue.

TABLE 16BC
YUKON GOVERNMENT REVENUE
BASE CASE SIMULATION
(MILLIONS OF DOLLARS)

	'82	'83	'84	'85	'86	'87	'88	'93	'98	2003
CURRENT DOLLARS										
TOT. TERR.	162.5	173.3	185.9	202.6	220.9	237.9	254.6	353.0	486.0	686.4
IND. TAXES	14.9	16.1	17.4	19.8	22.2	23.9	25.6	34.9	46.9	66.5
OTH. CURRENT	6.1	6.6	7.2	8.1	9.0	9.7	10.4	14.5	19.8	28.0
TOT. LOCAL	27.2	29.1	31.6	35.3	39.2	42.4	45.5	63.2	86.4	122.9
IND. TAXES	4.6	5.1	5.5	6.3	7.1	7.7	8.2	11.5	15.8	22.7
OTH. CURRENT	5.1	5.4	5.9	7.0	8.0	8.8	9.4	12.9	17.1	24.4
CONSTANT 1983 DOLLARS										
TOT. TERR.	172.4	173.3	175.2	180.0	185.0	187.8	189.5	195.5	200.2	210.4
IND. TAXES	15.8	16.1	16.4	17.6	18.6	18.9	19.1	19.3	19.3	20.4
OTH. CURRENT	6.5	6.6	6.8	7.2	7.5	7.7	7.7	8.0	8.2	8.6
TOT. LOCAL	28.9	29.1	29.8	31.4	32.8	33.5	33.9	35.0	35.6	37.7
IND. TAXES	4.9	5.1	5.2	5.6	5.9	6.1	6.1	6.4	6.5	7.0
OTH. CURRENT	5.4	5.4	5.6	6.2	6.7	6.9	7.0	7.1	7.0	7.5

TABLE 16HI
YUKON GOVERNMENT REVENUE
HIGH GROWTH SIMULATION
(MILLIONS OF DOLLARS)

	'82	'83	'84	'85	'86	'87	'88	'93	'98	2003
CURRENT DOLLARS										
TOT. TERR.	162.5	176.4	193.7	216.0	241.3	266.9	319.6	562.7	927.2	1597.0
IND. TAXES	14.9	16.1	17.8	20.6	23.5	26.0	35.8	53.2	85.2	145.7
OTH. CURRENT	6.1	6.7	7.4	8.4	9.5	10.5	13.5	20.4	32.2	52.8
TOT. LOCAL	27.2	29.5	32.7	37.4	42.4	47.2	61.2	102.4	168.1	291.0
IND. TAXES	4.6	5.1	5.7	6.6	7.5	8.4	11.4	17.7	29.5	51.8
OTH. CURRENT	5.1	5.5	6.1	7.3	8.5	9.4	14.1	20.2	31.0	51.3
CONSTANT 1983 DOLLARS										
TOT. TERR.	172.4	176.4	182.6	191.9	202.1	210.7	237.8	311.6	382.0	489.6
IND. TAXES	15.8	16.1	16.8	18.3	19.7	20.5	26.6	29.5	35.1	44.7
OTH. CURRENT	6.5	6.7	7.0	7.5	8.0	8.3	10.0	11.3	13.3	16.2
TOT. LOCAL	28.9	29.5	30.8	33.2	35.5	37.3	45.5	56.7	69.3	89.2
IND. TAXES	4.9	5.1	5.4	5.9	6.3	6.6	8.5	9.8	12.2	15.9
OTH. CURRENT	5.4	5.5	5.7	6.5	7.1	7.4	10.5	11.2	12.8	15.7

TABLE 16LBP
YUKON GOVERNMENT REVENUE
LOW BUT POSITIVE SIMULATION
(MILLIONS OF DOLLARS)

	'82	'83	'84	'85	'86	'87	'88	'93	'98	2003
CURRENT DOLLARS										
TOT. TERR.	162.5	170.7	181.9	193.8	206.7	220.4	235.0	325.0	451.8	630.7
IND. TAXES	14.9	15.2	16.3	17.4	18.6	19.9	21.2	29.4	41.0	57.4
OTH. CURRENT	6.1	6.3	6.8	7.3	7.8	8.3	8.9	12.5	17.5	24.5
TOT. LOCAL	27.2	28.3	30.4	32.4	34.8	37.2	39.8	55.7	78.0	109.6
IND. TAXES	4.6	4.8	5.1	5.5	5.9	6.4	6.8	9.6	13.6	19.3
OTH. CURRENT	5.1	5.1	5.5	5.0	6.5	7.0	7.5	10.7	15.3	21.6
CONSTANT 1983 DOLLARS										
TOT. TERR.	172.4	170.7	171.5	172.2	173.1	174.0	174.9	180.0	186.2	193.4
IND. TAXES	15.8	15.2	15.4	15.5	15.6	15.7	15.8	16.3	16.9	17.6
OTH. CURRENT	6.5	6.3	6.4	6.5	6.5	6.6	6.6	6.9	7.2	7.5
TOT. LOCAL	28.9	28.3	28.7	28.8	29.1	29.4	29.6	30.8	32.1	33.6
IND. TAXES	4.9	4.8	4.8	4.9	4.9	5.1	5.1	5.3	5.6	5.9
OTH. CURRENT	5.4	5.1	5.2	5.3	5.4	5.5	5.6	5.9	6.3	6.6

TABLE 16NEG
YUKON GOVERNMENT REVENUE
NEGATIVE GROWTH SIMULATION
(MILLIONS OF DOLLARS)

	'82	'83	'84	'85	'86	'87	'88	'93	'98	2003
CURRENT DOLLARS										
TOT. TERR.	162.5	163.6	168.0	172.8	178.0	183.4	188.9	220.4	259.3	307.4
IND. TAXES	14.9	14.7	15.3	16.1	17.0	17.9	18.8	24.3	31.8	42.0
OTH. CURRENT	6.1	6.2	6.5	6.9	7.3	7.8	8.2	10.9	14.6	19.6
TOT. LOCAL	27.2	27.2	28.1	29.2	30.4	31.6	32.9	40.2	49.6	61.9
IND. TAXES	4.6	4.6	4.9	5.1	5.5	5.8	6.1	8.2	11.0	14.9
OTH. CURRENT	5.1	4.8	5.0	5.3	5.6	5.9	6.2	8.1	10.5	13.7
CONSTANT 1983 DOLLARS										
TOT. TERR.	172.4	163.6	158.4	153.5	149.1	144.8	140.6	122.0	106.8	94.2
IND. TAXES	15.8	14.7	14.4	14.3	14.2	14.1	14.0	13.5	13.1	12.9
OTH. CURRENT	6.5	6.2	6.1	6.1	6.1	6.2	6.1	6.0	6.0	6.0
TOT. LOCAL	28.9	27.2	26.5	25.9	25.5	24.9	24.5	22.3	20.4	19.0
IND. TAXES	4.9	4.6	4.6	4.5	4.6	4.6	4.5	4.5	4.5	4.6
OTH. CURRENT	5.4	4.8	4.7	4.7	4.7	4.7	4.6	4.5	4.3	4.2

revenue climb to 20 percent of total Territorial government revenue in the year 2003, and to 46.3 percent of total local government revenue.

The extent of Yukon's heavy net dependence on federal government is brought out by a comparison of total federal spending in Yukon, on the one hand, and federal income derived from Yukon, on the other. In 1978, the federal current account budget in Yukon was in deficit by $58.2 million on revenue of $80.5 million and expenditure of $138.7 million.[1/] These spending and deficit figures exclude federally financed gross fixed capital formation, which may have reached $45 million in that year.[2/]

The extent of net dependence on the federal government is emphasized here because, in fact, revenue currently collected by the federal government could, with appropriate statutory changes, be collected by the Territorial government and Yukon local governments. By looking solely at the federal deficit position in Yukon one gets a clearer idea of just how important the federal budget is to the Territory. If, for example, the federal current account deficit in Yukon was maintained at a constant percentage of total

1/The Yukon Economic Accounts [9A] somewhat desguise this by not including loans in the spending total from which revenue is deducted in determining the deficit. In [9A] the 1978 federal deficit in Yukon is listed as $49.6 million.

2/In total, about 75 percent of Territorial government revenue was federal transfers in 1978. Total gross government capital formation in that year came to $58.6 million. The Yukon Economic Accounts do not itemize gross government capital formation by level of government.

current account federal expenditure in Yukon equal to the 42 percent posted in 1978, in the year 2003 the dollar level of the federal deficit in Yukon would be (1983 dollars):

YEAR 2003 FEDERAL CURRENT ACCOUNT DEFICIT	SIMULATION
$325.1 million	(HIGH GROWTH)
$142.5 million	(BASE CASE)
$133.4 million	(LOW BUT +)
$ 56.5 million	(NEGATIVE)

To these totals would need to be added any net federal expenditure for gross capital formation.

IV. SPECIAL PROJECT ANALYSIS

This chapter does two things. For reasons of access, it collects a number of results which indicate the approximate job, income, and population generating characteristics of certain developments. This is preceded by a discussion of the rationale for government investments in the subsidies to developing economies. These two themes are very closely related, in that a government considering direct intervention aimed at stimulating growth in an underdeveloped region would certainly be interested in knowing the relative job and income creating power of its policy alternatives.

- A RATIONALE FOR DEVELOPMENT SUBSIDIES -

THE RELEVANCE OF UNCERTAINTY

The investment problem facing federal and Yukon authorities is not merely how best to allocate public funds to the millions of dollars of capital projects appearing on one wishlist or another, projects such as roads, schools, community centers, and recreational facilities. Yukon public investment decisions are more complex than that. Authorities need to determine which uses (if any) for scarce public capital will do the most to leverage private development capital in one of the riskiest, highest cost investment climates in North America. The point here is not simply how best to piggy-back public funds onto those projects that are eminently financeable in private

capital markets, but rather how to target public funds in a way that fundamentally alters the terms of highly uncertain private investments.

As Nobel prize winning economist Kenneth Arrow has so often made clear, the presence of uncertainty changes the very nature of investment decisions. Conclusions that are clearcut in a world of perfect certainty may be entirely wrong in the face of uncertainty. Uncertainty can drive a wedge between the optimal investment decision from a private point of view, and the optimal investment decision (over the same set of choices) from the public point of view.

The key elements creating the public-private difference in viewpoint are risk sharing and diversification; risk sharing, in the sense that the risk attendant upon a public investment decision can be shared by the entire public; diversification, in the sense that a given public investment need not be dependent upon a single development project for its payback.

Quite obviously, a public decision to tread where private investors decline to walk, is not a decision to be taken lightly, and there are no guarantees of success. In light of this, it may be worthwhile to offer a not-so-far-out example of how public funds can be used to achieve a socially desireable increase in private investment.

Consider a case where there are five geographically proximate, independently owned mining prospects, known to be promising. Suppose that on the basis of current market expectations and partial geological information, the best guess is that each has a twenty percent chance of yielding an adequate after tax rate of return when one includes an as yet unbuilt transportation link in the cost of development (which could serve all five). Also suppose that studies show that if all five mines were to be developed and only one proved to be profitable, the revenue from the one would not cover the total development costs of the five.

Under these circumstances it is likely that until expectations change (a) no single firm would finance the transportation link and further development of its prospect, because the odds are only 1 in 5 that the investment will pay off at this time; and (b) the five firms as a group will not jointly finance the link and the development of all five prospects because their shared expectations are that, taken as a whole, the combined project is not now sufficiently profitable.

Uner these circumstances the prospects would be inactive until market conditions raised expected profits for one of the five by enough to cover further mine development and the cost of the transportation link. The waiting period could be many years.

Enter now a public investment agency. Since each mine has a twenty percent chance of success, there is a sixty-seven percent

chance that at least one will produce revenue adequate to cover its own site costs, the cost of the transportation link and yield a reasonable profit.[1/] Under these circumstances, it would seem that construction of the transportation link by the public agency could be the socially preferable option, since the public agency (through a temporary subsidy that raises long term risk-adjusted, profitability) can accellerate an investment that has a sixty-seven percent chance of creating long term jobs and income.

The point, of course, is not that the authorities should immediately run out and build transportation links, but that public investment decisions are complicated in a world of uncertainty, by the fact that public funds can serve more than their obvious traditional purposes. In this illustration the key difference between public and private decision makers is the public's ability to play the game five times at a price that excludes development costs other than those incurred in building the transportation link.

TEMPORARY SUBSIDIES CAN MAKE A DIFFERENCE

Subsidies can be classified with respect to their duration as either permanent or temporary. Permanent subsidies do little to help wean the Yukon economy from its extreme dependence on the federal government. When the source of subsidy dries up, the subsidized industry is placed in jeopardy. Temporary subsidies, on the other hand,

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1/That is, there is only a 33 percent chance that all five will fail, since $(.8)^5 = .328$.

could play a rôle in generating growth in industries which can become independent.

In principal, temporary subsidies can create permanent job gains in at least six ways, not all of which are necessarily important in Yukon.

1. Increased Market Share

   If an initial subsidy leads to the establishment of a significant part of an industry in Yukon (on a national or international scale), the Yukon operators may gain enough market power to enable them to pass their higher costs onto their customers. A Yukon illustration is hard to develop. However, one from Alaska makes the point. If Alaska seafood processors eventually handle all or virtually all of the bottomfish caught in Alaska waters, as a group they would control an important segment of the World's food supply. Under such circumstances, they could act as price setters rather than as price takers. Removal of the subsidy could then lead to higher product prices and not simply to lower profits.

2. Scarce Materials, Multi-Price Markets

   Yukon has been called a storehouse of raw materials. At the present time, the United States imports a high percentage of its strategically important raw materials from potentially unstable or unfriendly nations. Examples include copper, tungsten, and zinc. Just as the U.S. Congress has determined

that farm price supports are in the national interest, so could it determine that the purchase of (possibly) high priced Yukon metal is in the national interest, even if lower cost supplies were available from other countries. If this were to happen, permanent subsidies necessary to initiate certain ventures may be shiftable. In essence, the function of subsidizing the venture would be passed onto the U.S. government.

3. The Bootstrap Effect

This effect should be viewed as operable only in conjunction with gains in overall Yukon economic activity. In effect, is says that the total may be larger than the sum of the parts.

As one result of an overall development effort, certain products which might initially need to be subsidized may eventually be producible at a normal profit for sale to an enlarged Yukon market at prices below that of imports. The effect could be realized either through economies of scale or simply because a smaller percentage of larger markets is enough to insure profitability. Yukon producers would be partly shielded from outside competition by the cost of shipping consumer or bulk goods to Yukon. However, at Yukon's present size this effect is not likely to be important.

4. Induced Growth

In addition to normal support jobs which would be generated in response to subsidized basic sector growth, other jobs in industries not strictly of a support nature could come into existence as Yukon markets grow larger. If the ratio of induced government revenue to induced government spending eventually rises above unity (eventually it must, or else there would be no balanced government budgets, anywhere), the extra revenue could be used to help to maintain the initial subsidies on the basic growth that started the process. The initial subsidy may stay in place. However, taken as a whole, the new economic activity receives a reduced net subsidy. In principal, the net subsidy could ultimately go to zero.

5. Uniquely Yukon Products

With proper marketing, furs, carvings, conceivably even macho Yukon beer could be sold at a premium price on national and World markets. If marketing efforts were successful, initial subsidies could be phased out.

6. Lower Cost of Doing Business

In the long run, the cost of doing business in Yukon will decline relative to the cost elsewhere as economies of scale take effect, and as competition increases. To the extent new subsidized development increases the size of Yukon markets, it can be effective in lowering the relative cost of doing business in Yukon, and therefore, it can be effective in removing part of the need for subsidy.

In addition, lower costs of doing business in Yukon can contribute to secondary economic growth of the sort discussed in (4) above. To the extent this happens, net subsidies can decline, possibly to zero.

It would be a step ahead if these six effects had already been quantified for a range of development projects. Because the needed quantification appears not to exist, one cannot conclude that temporary subsidies will indeed work effectively. The strength of the six effects listed above may be insufficient. One should, however, be prepared to conclude that the question is open and deserving of future research. In the remainder of this chapter a step towards quantification is taken, by presenting the estimated job, income, and population generating effects of certain development projects.

- PROJECT IMPACTS -

Socioeconomic impact analysis can be performed at several levels of abstraction. It is possible, given enough time and adequate analytical resources, to describe in great detail and with a high degree of confidence the economy-wide changes in employment, income, population and other elements of interest, that can be expected to result from the initiation and continuation of a particular development project.

One can partition the ultimate ex-post error in a given socioeconomic impact analysis into (i) a portion attributible to imperfect methods of analysis; (ii) a second portion attributable to human error on

the part of the analyst; (iii) a third portion attributable to limitations in knowledge on the part of analysts as a whole; and (iv) what can be called "residual uncertainty," uncertainty which stems from an incomplete or incorrect specification of the (literally infinite) set of possibly determining factors. Although none of these four sources of error may ever be eliminated, it would seem always possible to reduce their importance at least a little, if one applies enough time and enough specialized resources to the problem.

In any given situation where knowledge of socioeconomic impacts is required, the policymaker, in team with the analyst, can choose an acceptable risk of error in the impact estimates by trading off accuracy and completeness for time and money; in effect recognizing that further reductions in the probable error of estimation are not worth the additional cost of purchase. Where this line is drawn depends, of course, on the situation.

The project impacts presented in this chapter were prepared with the aid of the NEWYEM econometric model. (In particular, see Table 11 in Chapter III.) Because this model is new and has not got an established track record, it cannot be said that the potential error from use of an imperfect tool of analysis has been minimized with respect to what the state-of-the-art will allow. Furthermore, at the level of aggregation chosen for this analysis, residual uncertainty is considerable. That is, one can be certain that the results will understate what is achievable from some projects, and overstate what is achievable from others. These limitations have

been accepted because the number of projects for which impact estimates were to be made was large relative to the time and resources available. Despite these limitations, we believe the following impact estimates to be informative and suitable for preliminary policy analysis. In cases where a particular project is proposed and is large, or it is in direct competition for public resources with some other specific development projects, a more complete project-specific analysis would be called for.

In what follows a "job" is one full-time person year of employment. All impacts are measured at the end of five years.

MINING JOBS

Mining jobs can be created or restored in Yukon with the aid of direct government financial or regulatory assistance. In turn, mining jobs create private sector jobs in other sectors of Yukon economy when mining wages are respent or when mining companies purchase goods and services from other Yukon establishments. Because some newly created jobs in Yukon are filled by migrants, employment growth tends to increase population and the demand for the services of Territorial and local government.

If 100 new mining jobs were created or restored and sustained in Yukon an additional 150 to 160 new jobs would be created or restored elsewhere in Yukon economy. Disposable personal income would rise by $16.2 million per year (1983 dollars), and Yukon's population

would increase by approximately 160 persons. For reference purposes, Cyprus Anvil annually generated approximately 150 to 200 man-years of employment (our definition of "jobs"), when in full scale operation, dependent upon seasonal conditions.

Because separate earnings data are not available for placer mining, mining exploration, and hardrock mining, these estimates do not go to the differences among the three types of jobs. The estimates best define a roughly balanced increase of 100 jobs of roughly historical proportions.

EXPENDITURE BY TOURISTS

Spending by visitors to Yukon provided an estimated 1,650 Yukon jobs in 1982. These jobs were either in the tourist industry per se, or were supported by the respending in Yukon of money earned in the Yukon tourist industry or by in-Yukon purchases of goods and services by tourist industry establishments.

The NEWYEM econometric model projects that if per-tourist expenditure holds at the 1982 level in real terms and if the number of tourists increases, then one new Yukon job would be created somewhere in Yukon's economy for every 220 person increase in tourist traffic. If, for example, annual tourist traffic increases by 10,000 persons, after five years, approximately 45 new jobs would be created, providing an additional $736 thousand in disposable personal income (1983 dollars). Under these assumptions, Yukon population would increase by 20 to 25 persons.

The postulated increase of 10,000 tourists is only a 2.7 percent gain relative to the 1982 tourist count of 367 thousand persons. The same postulated expenditure increase (2.7 percent) could be achieved by a 2.7 percent increase in real spending per tourist. This raises a vital question. Which is easier to attain, an X-percent increase in per-tourist expenditure or an X-percent increase in the number of tourists? For small X, there is probably little difference. Consider, however, a fairly large percentage increase, say 25 percent. Which is easier to attain, an increase from $148.18 to $185.22 in real per-tourist expenditure (1983 dollars),[1/] or an increase of 91,700 visitors to Yukon? Both deliver the same gain in real per-tourist expenditure.

Given the substantial decline in official estimated real per-tourist expenditure (see [31]), a close look at the reasons for this decline may be in order, and may suggest the means to counter it.

LARGE CONSTRUCTION PROJECTS

In and of themselves, isolated large-scale construction projects do little to support permanent or long-term in-Yukon employment. By their very nature, construction projects provide temporary stimulus to the economy. The temporary nature of the stimulus provided by construction projects argues against their being adopted solely for purposes of job creation. While the maintenance of some reasonable level of construction industry employment is an understandable

1/ In 1982 per-tourist expenditure was $139.70. This is $148.18 in 1983 dollars.

goal of public policy, the difference between this and advocacy of large scale projects solely on the basis of the jobs they create, is great.

Inclusion of large scale construction projects in this section of the report, reflects their probable coincidence with other major projects. Mine openings require the construction of roads, bridges, and other facilities and structures. Increases in tourist expenditure ultimately increase the demand for rooming space. Because the job and income creation impacts quantified here and elsewhere in this report are long-term in nature, they omit, by definition, the short-term or cyclical effects of associated construction expenditure. These effects are quantified in this chapter.

In 1978, the most recent year for which payroll data are available, reported construction payrolls per job were more than twice those in mining. In the previous year they were 35 percent greater than in mining. Unless the data are in error, it is clear that construction payrolls per job are not only high but quite variable, with the variation (undoubtedly) a function of season length and type of work being done. In 1978 Yukon construction industry employment achieved a recorded high of 801 jobs, a level not surpassed through 1982.

Large scale construction projects (such as construction of the gas pipeline from Prudhoe Bay, or the building of large hydroelectric plants) can be expected to draw a higher percentage of their work-

force from outside Yukon, than would small scale construction. Furthermore, relative to other industries such as mining, newly hired non-resident construction workers are more likely to leave Yukon when the job is completed, and therefore, are more likely to have their families residing outside Yukon.[1/] This last consideration suggests that even if Yukon businesses mistakenly identified a temporary construction boom as permanent, the total number of Yukon jobs created in the short run outside the temporary project would be less than if an equal payroll were earned by workers in other industries. Workers with families outside Yukon can be expected to spend less in-Yukon than they would if their families were residing in the Territory.

For the most part, materials used in major construction projects, other than gravel or fill, must ultimately be purchased outside Yukon. Apart from direct labor and transportation services, a major construction project would have little need or, indeed, opportunity to purchase goods or services in Yukon. For this reason, the total job and income creation effects of such projects are likely to be closely approximated by the impacts associated with the payment and re-spending of project direct payrolls. These impacts are given below per 1,000 year-round full-time equivalent jobs, each assumed to earn their holder $50,000 per year (1983 dollars). The assumption is made that all wages are paid to per-

1/The conjectures follow from two characteristics of the project in question: large and temporary. With annual employment in construction of some 600 jobs, Yukon would have a difficult time filling the peak 4,000 or so jobs on the gasline from resident applications.

manent Yukon residents. Indirect impacts per dollar of payroll would be (roughly) proportionately lower if some fraction of wages is immediately sent outside Yukon.

The numbers are (annual rate):

DIRECT JOBS	DIRECT WAGES/YEAR	IND. JOBS	IND. WAGES
1,000	$50 Million	800	$17.5 Million

These impacts (calculated from the disposable income multipliers in Table 11) can be expected to be temporary and to overstate the actual impacts by an amount that depends upon Yukoner perception of the temporary nature of the construction project, and the fraction of project payrolls sent immediately outside of Yukon.

The expected temporary surge in population associated with large scale construction jobs has a hefty speculative component which cannot be confidently estimated, but which can range as high as 1.5 to 2.0 times the temporary surge in employment.[1/]

APPROXIMATE EFFECTS OF "HIGH GROWTH" ASSUMPTIONS

Table 17 completes the presentation of the project-specific economic impacts of development alternatives in Yukon. For each of the seven assumptions which define the HIGH GROWTH simulation (Chapter

1/See Reaume [23B] for a discussion and empirical evidence on the predictability of net migration.

TABLE 17

DIFFERENTIAL IMPACT OF "HIGH GROWTH" ASSUMPTIONS
IN THE YEAR 2003

	EMPLOYMENT	DISPOSABLE INCOME/1	POPULATION
DIFFERENCE: "HIGH" less BASE CASE	18,691	447.2	30,823
PORTION OF DIFFERENCE DUE TO:			
H1 (Gold & Silver Prices)	190	5.5	313
H2 (United Keno Hill)	695	19.9	1,146
H3 (Tom & Jason)	500	14.4	825
H4 (Tourist Spending)	4,721	101.7	7,785
H5, H6 (Federal Spending)	12,207	294.9	20,130
H6 (Compositional - Included In H5)	---	---	---
H7 (Gasoline Operation)	378	10.8	624

1/Millions of 1983 dollars.

III), the incremental employment, disposable income, and population impacts have been identified. The changes shown include both the direct effects and the indrect or induced effects. For example, of the total increase from the BASE CASE of 18,691 jobs, Assumption H1 accounts for 190. Of the total income gain of $447.2 million (1983 dollars), H1 accounts for $5.5 million; and of the 30,823 person total population increase, H1 accounts for 313.

In examining Table 17, one may get a clearer picture of just how much additional mining activity would be needed to produce the HIGH GROWTH simulation's overall employment gains, if, say, federal spending were to remain at the levels projected in the BASE CASE scenario. In a very important way, Table 17 makes it clear just why the HIGH GROWTH scenario is judged to indeed be high. In our opinion, the probability of federal spending following a much lower growth path than that assummed in the HIGH simulations is somewhat greater than the probability of an equally stimulative (offsetting) increase in mining activity or tourist expenditure.

V. ENVIRONMENTAL CONSIDERATIONS/WATER DEMAND

In this chapter we present a compilation of information pertinent to a serious analysis of the environmental impacts of economic growth in the Yukon. We doubt that the material presented here will be new to such informed agencies as Environment Canada and the Yukon Conservation Society. Within the scope of the contract under which this study has been conducted, it simply was not possible to break new ground in this field. Nevertheless, the material presented here can serve a real purpose if its position alongside an economist's projections of economic growth helps to keep environmental matters from being overlooked. In the final section of this chapter, a set of forecasts of Yukon water demand is offered.

WATER EFFLUENT GUIDELINES

There are no formal overall water quality standards presently in force in the Yukon. Under the Northern Inland Waters Act of 1970 control via license is exercised by the Yukon Water Board, itself a part of the Department of Indian Affairs and Northern Development. In March 1983, wastewater standards were published by the Yukon Water Board [9B].

In a publication now somewhat outdated, the Canadian Institute of Mining and Metallurgy [6] compiled what it referred to as "the current, average range of effluent standards or guidelines established by the various jurisdictions." These are reprinted here as Table

TABLE 18

WATER EFFLUENT GUIDELINES

ELEMENT OR COMPOUND	RANGE OF GUIDELINE[1/] IN MG/L (PPM)	COMMENTS[2/]
Solids Dissolved	2,500 or less	
Solids Suspended	15 to 50	Histological changes may begin at 20 G/L.
pH	6.0 to 10.0	Literature suggests 5.0 to 9.0 is tolerable.
Arsenic	0.05 to 0.25	5 MG/L lethal to daphnia.
Cadmium	0.005 to 0.02	Toxic to fish as low as 0.63 MG/L. At .0026 MG/L Cad. Chloride immobolized daphnia.
Chromium	0.05 to 0.5	Toxic cutoff for insects may be as low as 2 MG/L.
Copper	0.03 to 0.30	May be toxic to fish at 0.15 MG/L. Concentration of 0.05 MG/L fatal to sea urchin larvae.
Cyanide as CN-	0.02 to 0.1	May be toxic to fish at 0.05 MG/L.
Iron	0.3 to 1.5	Not normally toxic. Can be lethal if suspended.
Lead	0.05 to 0.2	Can retard growth in guppies at 1.25 MG/L. Can be toxic to fish in soft water at 0.1 MG/1.
Mercury	0.001 to 0.005	May be toxic to fish at 0.3 MG/L.
Molybdenum	0.5 to 1.0	Rabbits affected at 0.5 MG/L.
Nickel	0.3 to 1.0	Toxic to daphnia at 0.7 MG/L.
Sulphate as SO_4	50 to 500	Constituent of sulphuric acid.
Zinc	0.15 to 1.0	Toxic to shellfish at concentrations as low as 1.0 MG/L. Concentrations of 1.15 retarded growth of guppies. Toxic to daphnia at 1.0 MG/L.

1/Table 11 in reference [6].

2/Taken from "The Disposal of Mining and Milling Wastes, With Particular Reference To Underwater Disposal," [5], in turn a review of the literature. As stated in the text of this chapter, results of the Northeastern New Brunswick Water Quality Program suggest that allowable concentrations should be no more than 10 percent of the incipient lethal concentration. [3, p. 52].

18. Also included in Table 18 are comments taken from a review of the literature conducted for the British Columbia Provincial Water Resources Services [5].

Concern over the possible toxic effects of mine wastes on fisheries, wildlife and people intensified during the 1960's. In November 1970, the Northeastern New Brunswick Mine Water Quality Program began a two-year study of the problem. In November 1974 a summary of the program's findings was published in the CIM Bulletin under the title "Salmon and Mining in Northeastern New Brunswick." One of the major findings of this study was that "the effective toxicity of metals was reduced by naturally occurring chelating agents such as humic acids." (p. 49) This finding explained why salmonids were surviving with no apparent difficulties in waters where the actual concentration of one or more metals exceeded the incipient lethal concentration. The observation led to the recommendation of water quality standards stated in terms of deviations from background (natural) levels.[1/] According to the CIM summary, "the most important single criteria derived in the Program was that metal toxicity in the receiving stream should not exceed (a concentration of 10.0 percent of the incipient lethal concentration), or in the event of the background level being greater than this should not exceed background toxicity." (p. 52)

1/The interested party can consult [3], p. 49 for a tabulation of the recommended stream requirements.

MINING AND MILLING WASTES

The principal waste disposal problems likely to be faced in the Yukon for the foreseeable future will continue to be the handling of mining and milling wastes, and the disposal of human waste (sewage and solid waste).

In terms of quantity of material, the greatest disposal problems faced by the hard rock mining and milling industry are the handling of overburden and gangue (mining) and the disposal of tailings (milling).[1/] Where mine openings come in contact with the water table and contain pyrites or certain other sulfides (such as at Cyprus Anvil), acid mine drainage can have detrimental effects on the environment. Milling operations face the task of disposing safely of water decanted from tailings ponds, and the related problem of runoff and leaching from such ponds. Table 18, above lists a sample of the elements and compounds that can be found in the water associated with tailings ponds. These elements and compounds either naturally occur in mine tailings or are introduced into mill wastes as the result of the additions of metallurgical reagents used in the separation of the various minerals from each other and from host rock materials.

Erosion of overburden piles, tailing's ponds embankments, and dried abandoned tailings ponds themselves can be alleviated by revegetation. The recycling of water decanted from tailings ponds and the addition of lime to water which is returned to the environment can

1/This discussion benefitted greatly from the study by Williams [29].

significantly lessen the danger of subsequent water table toxification. The range of guidelines shown in Table 18, above, applies to water decanted from tailings ponds and returned to the environment. According to the latest issue of Milling Practice In Canada [6], as of the year 1977, 56 percent of all operations surveyed engaged in no revegetation, 42 percent did not recycle tailings ponds decantations, and 55 percent added neither lime nor other treatment to water returned to the environment.

One can approximate the quantity of tailings produced by a milling operation by the formula:[1/]

$$T = (1-A/B)M$$

where T is the quantity of tailings produced;
A is the "average" metal content of the raw ore;
B is the "average" metal content of the concentrate; and
M is the quantity of ore milled.

Using data provided by the Yukon Territorial Government in [30A] the annual volume of tailings which would need to be disposed of by each of four potential producing mines in the Yukon (assuming concentrates of 51 percent metal) can be roughly calculated to be:

Cyprus Anvil.....8,200 tonnes per day
Keno Hill..... 220 tonnes per day
Tom.....3,000 tonnes per day
Jason.....3,200 tonnes per day

1/Quantity of tailings equals quantity of milled ore (M) less quantity of concentrate (C). Ignoring metal in the tailings, A*M = B*C. Collect terms and simplify.

According to Stoke's Law, design of a tailings pond (assuming no addition of flocculating agents and a sufficiently low flow velocity of water through the pond) depends upon the specific gravities of tailings particles and of the pond fluid, the diameter of the tailings particles, the viscosity of the pond fluid, and the rate of flow of fluid through the pond.[1/] Wave action, turbulence and bottom scouring reduce the effective rate of sedimentation. For reference, the Cyprus Anvil tailings pond covers approximately 165 acres in Rose Creek Valley.

PLACER MINING WASTES

Working together, the Department of Indian and Northern Affairs, Environment Canada, and the Department of Fisheries and Oceans have recently developed a revised set of water treatment guidelines for placer mine operations in the Yukon. The new guidelines are intended to reduce the concentration of suspended solids in water released to the surface, to levels deemed acceptable by the Yukon Water Board. Effluent guidelines vary according to the "significance" of the area in which the mine is located. In the future, placer miners will be required to submit a mine development plan and to rehabilitate mined areas in accordance with the plan.

The federal government's new guidelines and analysis of cost and benefits is presented in a series of reports which include (1) Yukon Placer Mining Guidelines; (2) Socio-economic Impact Analysis For Yukon Placer Mining Guidelines; (3) A Rationale

1/See, for example, Williams [29], p. 17.

For The Suspended Solids Standards; (4) Benefit-Cost Analysis Of The Proposed 'Yukon Placer Mining Guidelines; (5) A Rationale For The Classification of Rivers, Streams, and Lakes; and (6) The Attainment and Cost of Placer Mining Effluent Guidelines.

MUNICIPAL WASTEWATER

According to the Municipality of Whitehorse, metered water consumption in 1982 was 953 million gallons and sewage flow approximately 25 percent greater, or an estimated 1,190 million gallons. This is approximately 195 gallons of sewage per person per day. As a rule of thumb, a municipality usually returns about 7 gallons in sewage for every 10 gallons of water initially supplied.[1/]

In March 1983, the Yukon Water Board published "Guidelines For Municipal Wastewater Discharges In The Yukon Territory," [9B]. Objectives have been stated in terms of acceptable levels of basic oxygen demand (BOD), suspended solid, pH, oil and grease, phosphorus, fecal coliforms, and toxic organic substances. These levels are themselves dependent upon the diluting potential of the water body into which the wastewater is poured. The intention behind the setting of these objectives are the following receiving water quality objectives.

Dissolved Oxygen.....7 MG/L

Total Residual Chlorine.....Less Than .02 MG/L

1/Handbook of Water Resources and Pollution Control [11], p. 430. The excess of sewage volume over initial water supplied is accounted for by run off, ground water infiltration, and sewage system use by persons supplying their own potable water from wells and creeks.

Fecal Coliforms.....200 Counts/100 ML

Settleable Solids.....Negligible Increase

Floatable Solids & Scum.....Negligible Increase

Oil and Grease.....Less Than 1 MG/L (surface sample)

Organisms.....No Undesireable Change In Productivity

Metals.....Negligible Increase

According to data reproduced in [11], average per capita solids in domestic sewage are

GRAMS PER CAPITA PER DAY

STATE OF SOLIDS	MINERAL	ORGANIC	TOTAL
Suspended	25	65	90
Settleable	15	39	54
Nonsettleable	10	26	36
Dissolved	80	80	160
TOTAL	105	145	250

If these estimates are approximated in the Yukon, the annual weight of suspended solids contained in sewage is approximately 33 kilograms per person per year, and of dissolved solids approximately 58 kilograms per person per year. By these standards, in 1982 Yukon sewage contained approximately 820 metric tonnes of suspendable solids and 1,440 metric tonnes of dissolved solids. Although sewage production tends to increase as standards of living increase, the per capita figures offered here may not too badly distort the future potential when multiplied by the population forecasts given earlier. The results of this exercise are given in Table 19.

TABLE 19

SOLIDS IN DOMESTIC SEWAGE
YUKON
(Metric Tonnes Per Year)

STATE OF SOLIDS	1982	1983	1984	1985	1986	1987	1988	1993	1998	2003
SUSPENDED										
Base Case	820	819	828	845	864	877	885	919	949	999
Low But +	820	804	810	815	820	826	831	861	895	933
Neg. Growth	820	762	759	756	754	753	751	743	736	730
High Growth	820	823	836	857	881	901	1131	1376	1615	2016
DISSOLVED										
Base Case	1440	1439	1454	1485	1519	1542	1556	1616	1669	1756
Low But +	1440	1414	1423	1432	1442	1451	1461	1513	1573	1640
Neg. Growth	1440	1338	1333	1329	1326	1323	1320	1305	1293	1283
High Growth	1440	1446	1469	1506	1549	1583	1989	2418	2838	3543

SOURCE: See text.

WATER DEMAND, COMMERCIAL/RESIDENTIAL

The Handbook of Water Resources and Pollution Control [11] lists eleven factors which influence water demand in a community. They are:

1. Size and Type of Community. The larger the community, the narrower the range of fluctuation in demand. (A version of the law of large numbers, as it were.)
2. Standard of Living. The higher the standard of living, the greater the demand for water.
3. Community Location.
4. Quality of Water. Poor quality water results in a reduction in use.
5. Pressure. The higher the water pressure, the greater the use.
6. Sewers. Use of water increases when sewers are installed.
7. Metering. Use of metering decreases water useage.
8. Age of Community. Older, more stable communities use less water than rapidly developing communities.
9. Extent of Lawn Sprinkling.
10. Price. An increase in water rates tends to reduce consumption.
11. Air Conditioning.

Table 20 gives estimates of the per capita daily consumption of water for a "representative" family of four persons.

TABLE 20

ESTIMATED PER CAPITA DAILY CONSUMPTION OF WATER
FOR VARIOUS PURPOSES IN A FAMILY OF FOUR

Family Use per Day	DAILY (AVERAGES FOR ENTIRE YEAR) (gpd/family)	(gpd/person)
Drinking & water used in kitchen: 2 gal/person X 4	8	2
Dishwasher: 5 gal/load X 3 loads/day	15	3.75
Toilets: (2) 4 flushes/person X 6 gal/ flush X 4	96	24
Bathing: 20 gal/bath X 4	80	20
Laundering: $\frac{6 \text{ loads/week X } 40 \text{ gal/wash}}{7}$	34	8.5
Automobile washing: $\frac{2 \text{ cars X } 1 \text{ wash/car/month X } 150 \text{ gal/wash}}{30}$	10	2.5
Lawn watering: 2 hr/day X 90 days/yr X 200 gal/hr	100	25
Garbage disposal unit: + 1 percent X 343 gal/day	3	.75
TOTAL	346	86.5

SOURCE: Economic Systems Corporation, Appendix G in Urban Water Resources Research, American Society of Civil Engineers, Urban Hydrology Research Council, New York City, p. G 34 (1968).
Reprinted in [11] as table 2-8.

NOTE: U.S. gallons. 1 U.S. gallon = .833 Imperial gallons.

Municipality of Whitehorse tallies for 1982, show an average metered water consumption of 155 Imperial gallons per person per day,[1/] and sewage flow of approximately 195 imperial gallons per person per day.[2/] Engineering rules of thumb as given in [11] allow for seven gallons of sewage for every ten gallons of water supplied (ignoring storm run off). If this rule of thumb applies to Whitehorse, it suggests that total 1982 water consumption may have been as high as 280 gallons per person per day (gppd) if one counts consumption from private wells and streams. The difference between the (roughly) 70 imperial gppd shown in Table 20 and total Whitehorse water consumption per person, per day can be accounted for by commercial and self-supplied consumption and by "over-average" use in general. Table 21 gives estimates of commercial water use on a gallons per day basis.

During 1982, metered water consumption per capita in Whitehorse fell to 155 gppd from 170+ gppd in 1981, and an estimated 219 gppd in 1980. A part of the decline in 1982 reflected the slowdown in economic activity and a resultant decline in water use by hotels and other commercial establishments. (It is also possible that the 1982 Whitehorse population estimate is too high.)

Despite the changing year-to-year water consumption per capita which Whitehorse has experienced, one can rationalize the use of an "average" gppd figure for planning. The rationalization, quite simply, is that prices can be adjusted. As long as the gppd figure used is reasonably high relative to the biological needs of the

1/(953,000,000 ÷ 365)/16771.
2/Based on Whitehorse City estimates that sewage flow equals 1.25 times the metered water flow.

TABLE 21

PLANNING GUIDE FOR WATER USE

Types of Establishments	gpd
Airports (per passenger)	3-5
Apartments, mutlitple family (per resident)	60
Bath houses (per bather)	10
Camps:	
Construction, semipermenent (per worker)	50
Day with no meals served (per camper)	15
Luxury (per camper)	100-150
Resorts, day & night, with limited plumb.(per camper)	50
Tourists with central bath & toilet facilities (per person)	35
Cottages with seasonal occupancy (per resident)	50
Courts, tourist with individual bath units (per person)	50
Clubs:	
Country (per resident member)	100
Country (per nonresidential member present)	25
Dwellings:	
Boarding houses (per boarder)	50
Additional kitchen requirements for nonresidential boarders	10
Luxury (per person)	100-150
Multiple family apartments (per resident)	40
Rooming houses (per resident)	60
Single family (per resident)	50-75
Estates (per resident)	100-150
Factories (gal per person per shift)	15-35
Hotels with private baths (two persons per room)	60
Hotels without private baths (per person)	50
Institutions other than hospitals (per person)	75-100
Hospitals (per bed)	250-400
Laundries, self-serviced (gal per washing i.e., per customer)	50
Motels with bath, toilet, & kitchen facilities (per bed sp.)	50
With bed and toilet (per bed space)	40
Parks:	
Overnight with flush toilets (per camper)	25
Trailers with individual bath units (per camper)	50
Picnic areas:	
With bath houses, showers, & flush toilets (per picnicker)	20
With toilet facilities only (gal per picnicker)	10
Restaurants with toilet (per patron)	7-10
Without toilet facilities (per patron)	2½-3
With bars and cocktail lounge (additional quantity per patron)	2
Schools:	
Boarding (per pupil)	75-100
Day with cafeteria, gym, and showers (per pupil)	25
Day with cafeteria by no gym or showers (per pupil)	20
Day without cafeteria, gym, or showers (per pupil)	15

Table 21 - continued

TYPES OF ESTABLISHMENTS	gpd
Service station (per vehicle)	10
Stores (per toilet room)	400
Swimming pools (per swimmer)	10
Theaters:	
Drive-in (per car space)	5
Movie (per auditorium seat)	5
Workers:	
Construction (per person per shift)	50
Day (school or offices per person per shift)	15

NOTE: U.S. gallons. 1 U.S. gallon = .833 Imperial gallons.

SOURCE: [11] Table 2-9.

community, any tendency for residential/commercial consumption to exceed this figure can be viewed as evidence of the need for a price increase. The problem for planners lies in the threat of projecting too large a daily per capita consumption, since construction of an oversized system of water works depletes capital which might well be used more efficiently elsewhere.

Table 22 gives projections of the combined residential and commercial Yukon demand for water on the assumption that the 1981 estimate of metered consumption (gppd) in Whitehorse is "typical," and on the further assumption that this figure should be adjusted upward by 78.5 percent to allow for consumption from private wells and creeks.[1/] This upward adjustment is based on the following. If Whitehorse engineers are correct in their estimate that Whitehorse sewage flows are 25 percent higher than the amount of water initially supplied, and if the rule of thumb that states that sewage flows equal 70 percent of total water supplied is also correct, then the upward adjustment equals (1÷.70)*1.25, or the indicated 78.5 percent. The resultant estimate of Yukon commercial/residential water consumption is then 303 gallons per person per day (170 *1.785). It can be noted that [11] suggests a figure of 232 gppd for just residential water consumption (persons by municipal systems).[2/]

1/Recall that the 1980 estimate was nearly 30 percent higher than the 1981 estimates.
2/See [11] p. 45. The table is in U.S. gallons. These have been converted to imperial gallons in this text.

TABLE 22

PROJECTED RESIDENTIAL/COMMERCIAL
YUKON WATER DEMAND
(Millions of Imperial Gallons)

	1982	1983	1984	1985	1986	1987	1988	1993	1998	2003
Base Case	2744	2743	2773	2831	2897	2940	2967	3081	3182	3348
Low But +	2744	2696	2714	2731	2749	2767	2786	2886	2999	3127
Negative	2744	2552	2542	2535	2528	2522	2516	2489	2466	2447
High Growth	2744	2758	2800	2871	2954	3018	3792	4611	5412	6756

The Table 22 projections should be viewed as generous upper bounds. In a recent study published in the Journal of Forecasting [2], G.G. Archibald notes that in Mansfield England residential water consumption is only 99.7 liters per person per day, or 26.3 U.S. gallons. This is only 30 percent of the typical U.S. consumption recorded in Table 20. Clearly, current North American water consumption standards leave much room for conservation.

WATER DEMAND IN MINING

The only definitive study of water demand in mining which we know of is Kaufman & Nadler [18C]. The publication is old (1966) and therefore not likely to be indicative of current practice. Other problems in the Kaufman-Nadler report include use of gallons per dollar as a measuring rod, and failure to disaggregate mining and milling industries by type of ore.

According to the CIM [6], in 1977 the Cyprus Anvil mine required 4,000 U.S. gallons of water per minute to process 10,000 tonnes per day of ore. This estimate includes water for tailings ponds and may be

too high for general use and extrapolation because water reclamation was not practiced when the estimate was given. How future demand relates to the older Cyprus Anvil figure depends on the minerals mined, their minerology and the extent of reclamation.

The Departments of Environment and of Fisheries and Oceans recently used a "typical" placer mining water demand of 4000 (Imperial) gallons per minute over a 90-day mining season.[1/] Debicki [7] estimates that in 1982 there were 500 Yukon placer leases in good standing, down from 1,076 in 1980.

1/"The Attainment and Cost of Placer Mining Effluent Guidelines."

APPENDIX A: YUKON ECONOMIC ACCOUNTS

At this writing copies of the revised Economic Accounts had not been received from Statistics Canada. For this reason these comments will be directed more at the concept than at the substance of the revised accounts.

In order to serve the substantive needs of researchers, the Accounts should be timely and accurate, and have an independent information content. From the point of view of the public budget, they should be cost-effective. It goes without saying that if a dataset is untimely, inaccurate, and has little independent information content, then it is not likely to be worth the effort of compiling it. In general, experience with the Economic Accounts compiled by the Department of Indian and Northern Affairs [9A] led to the following conclusions, which may or may not pertain to the revised Accounts soon to be released by Statistics Canada.

1) Data were updated with a lag so long that the Accounts were severely limited in their usefulness. As of Spring 1983, data for 1978 were the most current.
2) Documentation describing the preparation of the dataset neither accompanied the published dataset nor was cited. Although such documentation exists, extra effort is required to obtain it.

3) The consumption series and the disposable personal income series implied an extremely high average propensity to save in the Yukon, .325 in 1977, .361 in 1975 [9A, Table 24].

In a version of the Accounts used by Dr. Jack Stabler in constructing the first Yukon econometric model, [27A], "consumption imports" were a constant 30 percent of consumption expenditure over time, and "government imports" a constant 39 percent of current government expenditure. The "consumption imports" and "government imports" series cannot be found in [9A] and, therefore, may be a construct of Dr. Stabler's. If, in fact, these two series are part of an expanded set of accounts, they damage the credibility of the entire dataset.

Construction of a set of territorial accounts with the scope of [9A] probably cannot be justified if the time series are largely constructs, as some of the series in [27A] appeared to be. Given a choice, most researchers, it is safe to say, would prefer a few key series with high information content and validity, to an extensive, but less informationally rich set of accounts. To this end, we suggest the following short list of variables which, in our opinion, are among the most important for economic analysis.

1. Personal Income gross of tax, by type of income.
2. Wage Income, by industry originating.

3. Proprietors' Income, by industry originating.
4. Business Purchases of current goods/services by purchasing industry.
5. Government Expenditure On Current Account, by level of government.
6. Construction Outlays (as opposed to capital outlays) by (a) business; (b) level of government; and (c) persons.
7. Intergovernmental Transfers.
8. Interest Rates.

With the possible exception of construction outlays, these data-series should be relatively easy to compile for a given year, six to nine months into the next year. Given these series (accurately tabulated) and items such as population, employment, prices, and the other data published, for example, in the Yukon Economic Review [9C], and in the various censuses and tax publications, one would have a sound, albeit modest, information base at what certainly should be a reasonable cost.

Compilation of items such as "consumption" which require the making of special surveys (if they are not to be mere constructs) probably cannot be cost justified at the Territorial level. Requiring staff economists to estimate such items without the aide of a survey, invites the use of currently fashionable economic theory in their estimation, and absorbs staff time which might be better focussed elsewhere.

APPENDIX B: MODIFICATIONS TO NEWYEM

In preparing the simulations of the Yukon econometric model which were discussed in this report, two equations in the model were altered. In this appendix the alterations are documented.

CONSTRUCTION PAYROLLS

The equation was changed in order to force annual payrolls per job to lie on a straight line over the years 1979 to 2006, such that in the year 2006 payrolls per job would have risen since 1979 at an annual average rate 1.0 percentage points greater than the rate of consumer price inflation. In 1979, construction payrolls per job (thousands of dollars) were equal to 54.55. Over the 1979 to 2006 period, an annual average rate of growth of 6.8 percent was projected for the Yukon consumer price index. This implied (given the previous assumption) that year 2006 payroll per job in construction would be 414.48. Letting AECYK = A+B*CPIYK, where AECYK is payroll per job and CPIYK the Yukon consumer price index, the values of A and B were found from the two equations:

$$54.55 = A+B*CPIYK \quad (1979)$$

$$414.48 = A+B*CPIYK \quad (2006)$$

The solved values for A and B were

$$A = -20.53$$

$$B = 55.78$$

LABOR FORCE

A dummy variable was incorporated into the labor force equation in order to place a ceiling of (approximately) 0.65 on the labor force participation rate. The dummy variable, DUMLC, was set equal to 1.0 in periods when the labor force participation rate would otherwise exceed 0.65. The new equation is

```
LCYK = NYK*(LCYK(-1)/NYK(-1) - .3876 + .3876*ETOTYK/
       ETOTYK(-1) - (LCYK(-1)/NYK(-1)-.65)*DUMLC)
```

where LCYK - labor force

NYK - population

ETOTYK - wage and salary employment

DUMLC - equals zero unless set equal to 1.0

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